Environmental Studies No. 10

Wildlife and Wildlife Habitat in the Great Slave and Great Bear Lake Regions 1974-1977

Northern Affairs Program

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Fort Rae,
Northwest Territories

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Cette publication peut aussi être obtenue en français.

PREFACE

The Land Use Information Map Series is now entering its eighth year of research in the Canadian North. During the past seven years, project staff have completed reconnaissance-scale environmental and social mapping for the western half of the land area north of 60°, or nearly 20 percent of Canada. A number of scientists and researchers have contributed to this project since 1971 and all are confident that the high standard of their work has helped the maps to become a key tool for land and resource management in the north.

Project staff have continually endeavoured to maintain close contact with the users of the maps produced. Whenever possible, we have tried to explain the proper application of the data shown on the maps, and to describe the research methods used. Despite that, it seems that many users would appreciate supplementary materials to help them understand and effectively use the maps now available. Our response to this need has been to develop an audio-visual presentation for staff training, as well as a series of user handbooks. All will be available in the spring of 1979. These handbooks will describe research methods for three subject areas: recreation-tourism, wildlife resources, and fisheries resources.

It is our hope that this handbook on wildlife research will provide users with an insight into the survey techniques and sampling methods used in the preparation of wildlife information for the Land Use Information Series. We also hope that the provision of basic background data will assist specialist users in interpreting and applying the material found on the maps.

The task of flying reconnaissance surveys in all kinds of weather far from settlements is no easy task. Roy Jacobson's steady and enthusiastic participation in this mapping project has added significantly to our knowledge of northern wildlife and I hope that this report will bring map users a better understanding of the extent of research carried out for the Land Use Information Map Series.

Ken Taylor
Project Coordinator
Spring, 1979.

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Ray Baert, bushpilot, was the pilot for virtually every survey, both with the Cessna 185 and the Turbo-beaver. The surveys were greatly improved by his good cheer and high degree of professionalism, often under extremely adverse conditions.

Ken Taylor, Project Co-ordinator, and the entire project staff at Lands Directorate, were very helpful. They were pleasant field companions and often transformed my field notes into readable map legends. John Reid laboured long to transform my sketches and graphs into presentable illustrations for the report. Ken Taylor was the driving force behind getting this report out of my field notebooks.

I appreciated the complete field freedom given me by my Canadian Wildlife Service supervisors. My field work was better because of it.

TABLE OF CONTENTS

1. INTRODUCTION 1
   - 1.1 Nature of the Study 1
   - 1.2 Objectives 2
   - 1.3 Summary of Observations. 2

2. THE STUDY AREA 9
   - 2.1 Bog and Forest Wildlife Zone 9
   - 2.2 Mossy Forest Wildlife Zone 9
   - 2.3 Glacial Lake McConnell Area Wildlife Zone 11
   - 2.4 Open Forest Wildlife Zone 11
   - 2.5 Forest-Tundra Transition Wildlife Zone 11
   - 2.6 Sparsely Vegetated Tundra Wildlife Zone. 11
   - 2.7 Lush Vegetation Tundra Wildlife Zone 11

3. RESEARCH METHODS 16
   - 3.1 Literature Review and Field Interviews 16
   - 3.2 Landform-Vegetation Mapping. 17
   - 3.3 Field Surveys 18
   - 3.4 Map Compilation 19

4. SURVEY METHODS, OBSERVATIONS AND DISCUSSION 23
   - 4.1 Moose 23
     - 4.1.1 Methods 23
     - 4.1.2 Observations and Discussion 24
   - 4.2 Barren-ground Caribou 27
     - 4.2.1 Methods 27
     - 4.2.2 Observations and Discussion 31
   - 4.3 Woodland Caribou 42
     - 4.3.1 Methods 51
     - 4.3.2 Observations and Discussion 51
   - 4.4 Bison 52
     - 4.4.1 Methods 52
     - 4.4.2 Observations and Discussion 53
   - 4.5 Muskox. 53
     - 4.5.1 Methods 53
     - 4.5.2 Observations and Discussion 57
   - 4.6 Bears 57
     - 4.6.1 Methods 57
     - 4.6.2 Observations and Discussion 61
   - 4.7 Forest Furbearers 62
     - 4.7.1 Methods 62
     - 4.7.2 Observations and Discussion 63
   - 4.8 Aquatic Furbearers. 64
     - 4.8.1 Methods 64
     - 4.8.2 Observations and Discussion 65
   - 4.9 Arctic Fox 65
     - 4.9.1 Methods 65
     - 4.9.2 Observations and Discussion 66

4.10 Wolf 66
    4.10.1 Methods 68
    4.10.2 Observations and Discussion 69
4.11 Migratory Waterfowl 69
    4.11.1 Methods 69
    4.11.2 Observations and Discussion 70
4.12 Raptors 71
    4.12.1 Methods 71
    4.12.2 Observations and Discussion 71

5. SPECIAL STUDIES - REACTIONS OF WILDLIFE TO AIRCRAFT 73
    5.1 Introduction 73
    5.2 Methods 73
    5.3 Observations and Discussion 73
    5.4 Conclusions 86

6. FIELD SURVEY NOTATION SYMBOLS 89
    6.1 Introduction 89
    6.2 Symbols 89
        6.2.1 Wildlife Symbols 89
        6.2.2 Vegetation Symbols 91
        6.2.3 Geomorphology Symbols 93

7. REFERENCES AND BIBLIOGRAPHY 94
    7.1 Selected References 95
    7.2 Bibliography 100
        7.2.1 Techniques 100
        7.2.2 Environment 101
        7.2.3 Geomorphology 103
        7.2.4 Vegetation 104
        7.2.5 Wildlife 104

APPENDIX 109

LIST OF FIGURES

Figure 1 - Outline of Great Bear and Great Slave lake Study Areas 3

Figure 2 - Location of Wildlife Zones 7

Figure 3 - Cross-section of Glacial Lake McConnell influence 12

Figure 4 - Typical survey transect coverage 20

Figure 5 - Example of field survey notation 21

Figure 6 - Relative abandance of moose by wildlife zone 25

Figure 7 - Caribou winter range: Mid-November & March 1974 33

Figure 8 - Caribou winter range: Mid-January & February 1975 35

Figure 9 - Caribou winter range: Early November & Mid-December 1975 37

Figure 10 - Caribou winter range: Mid-January 1977 39

Figure 11 - Caribou winter range: Mid-March 1975 43

Figure 12 - Caribou winter range: Early March 1976 45

Figure 13 - Bluenose herd calving grounds: Spring 1976 47

Figure 14 - Barren-ground caribou winter range: 1973-74 through 1976-77 49

Figure 15 - Woodland caribou calving activity in the Mackenzie Bison Sanctuary 54

Figure 16 - Wood Bison Habitat use - Mackenzie Bison Sanctuary 55

Figure 17 - Plains-Wood Bison Habitat use - Hook Lake area. 56

Figure 18 - Muskox distribution north of Great Bear Lake. 59

Figure 19 - Observed occupied Arctic fox and wolf dens, Summer, 1975 67

Figure 20 - Observed active golden eagle and whistling swan nesting sites, Summer, 1975. 75

Figure 21 - Observed active golden eagle and bald eagle nesting sites, Summer 1974 76

Figure 22 - Reactions to aircraft - Moose, year round 77

Figure 23 - Reactions to aircraft - Barren-ground caribou, winter resting 77

Figure 24 - Reactions to aircraft - Barren-ground caribou, winter, feeding 81

Figure 25 - Reactions to aircraft - Barren-ground caribou, summer, range. 81

Figure 26 - Reactions to aircraft - Bison 83

Figure 27 - Reactions to aircraft - Muskox. 85

Figure 28 - Reactions to aircraft - Wolf 87

LIST OF TABLES

Table 1 - Summary of Wildlife Observations 5

Table 2 - Classification of Caribou Tracks on Winter Range 29

Table 3 - Classification of Animal Reaction to Aircraft and Prior Activity 79

LIST OF PLATES

Plate 1 Bog and forest wildlife zone, south of Lac la Martre 10

Plate 2 Mossy forest wildlife zone, north of Colville Lake 10

Plate 3 Glacial Lake McConnell wildlife zone near Ft. Rae 13

Plate 4 Open forest wildlife zone, northeast of Yellowknife. 13

Plate 5 Forest-tundra transition wildlife zone, northeast of Beniah Lake 14

Plate 6 Sparsely-vegetated tundra wildife zones, near Bluenose Lake 14

Plate 7 Sparsely-vegetated tundra wildlife zones, Hornaday River headwaters 15

Plate 8 Lush vegetation tundra wildlife zones, Rae River valley 15

Plate 9 Barren-ground caribou sign, tracks and craters 30

Plate 10 Barren-ground caribou observations and sign. 30

Plate 11 Cow and calf moose feeding on summer range 78

Plate 12 Barren-ground caribou resting on winter range. 78

Plate 13 Barren-ground caribou feeding on the tundra. 82

Plate 14 Woodland caribou feeding on calving grounds. 82

Plate 15 Bull wood bison on summer range. 84

Plate 16 Wood bison feeding on winter range 84

Plate 17 Muskox on summer range 88

Plate 18 Adult wolf near den. 88

INTRODUCTION

In 1971, the Department of Indian Affairs and Northern Development established the Arctic Land Use Research (ALUR) Program to provide baseline environmental information for the Yukon Territory and the Northwest Territories. As part of this program, the Lands Directorate of Environment Canada undertook the preparation of Land Use Information Series maps (1:250,000 scale) which summarize information on renewable resources and related human activities. The Canadian Wildlife Service (CWS) was responsible for providing information on wildlife and wildlife habitat for the map series.

From February 1974 through March 1977, Environment Canada carried out research for the Land Use Information Series (LUIS) in the forest and tundra areas surrounding Great Slave and Great Bear lakes in the Northwest Territories. During that period, the author worked as a wildlife ecologist, under contract to CWS, as part of the interdisciplinary team which produced the map series. As part of the primary research, a series of year-round, multi-year wildlife surveys were conducted over approximately 518,000 km^2 (200,000 mi^2), essentially between 60^0N and the Arctic Coast and from the Mackenzie Valley east to well onto the tundra (Fig. 1).

1.1 Nature of the Study

The wildlife species studied were selected largely on the basis of social values. Habitats that were important or critical for the maintenance or survival of wildlife populations were outlined and ecosystems (wildlife zones) were described. Animals studied included: moose, barren-ground caribou, woodland caribou, bison, bears (grizzly and black), red fox, lynx, muskox, marten, wolverine, muskrat, mink, otter, beaver, Arctic fox, wolf, waterfowl, and raptors (falcons and eagles).

The vast area of forest and tundra which provides the habitat for the diverse wildlife of this study consists of many interrelated ecosystems: bog transitions to forest; prairie to lake; and open forest to tundra. Sharp contrasts also can be found, such as the vegetation of eskers versus adjoining tundra or forest, forest composition of the sedimentary plain versus that of the Canadian shield, or great variations in tundra vegetation, depending on underlying substrata.

Mapping wildlife habitat, and its use by wildlife, especially on a reconnaissance level, requires many value judgements concerning habitat differences. Often the mapping of land use for a certain species would suggest a series of slightly differing ecosystems at one level of detail, but a further analysis for another species or group of species would suggest a much larger and more generalized ecosystem. Thus, barren-ground caribou winter range may encompass virtually the entire open forest of the Canadian Shield, while within this same area, only certain river systems are used by otters for winter feeding. Marten may be abundant throughout the forests of the sedimentary plain whereas beaver may only be abundant in a small part. Some species appear to use the same ecosystems, but are concentrated in very different parts of it. For example, an esker system may provide abundant wolf denning sites, whereas a nearby pond system provides whistling swan nesting sites. Some species, very closely associated during part of the year and using the same habitat, are widely separated during the remainder of the year. Barren-ground caribou and wolves, for example, are interrelated and together on their winter range, yet have their young in widely separated locales, partly for habitat-related reasons. Yet, in other ecosystems, wolves and other species, (eg. bison and to some extent moose and woodland caribou) may live year-round together.

These and many other differences and similarities are reflected in the LUIS maps. The maps and the information portrayed are often general in appearance, but the symbols and legends reflect the overall, multi-year use of the entire ecosystem, based on multi-year surveys, interviews, literature review and habitat study.

Because of the long lead time required for a project of this nature, from initial budget planning through to the final map printing, several years are available for surveys. Initial interviews, literature review and surveys are generally begun up to a year before the start of the specific area field work. Data are frequently available from adjacent and similar study areas or from surveys which were extended beyond previous study area boundaries.

1.2 Objectives

The study aimed to define critical and important wildlife habitat and wildlife functions for culturally important species. This information was to be presented spatially at a 1:250,000 scale with accompanying narrative in conjunction with the other mapped subjects. Detailed methods and observations, in excess of the information portrayed on the map sheets, were to be presented in handbook form.

Some species and areas were mapped from existing information, and therefore received minimum emphasis during the field studies. These included polar bear, from work by Dr. I. Stirling, CWS (Stirling, Andriashek, Latour and Calvert, 1974). The Wood Buffalo National Park portion in the project area was excluded from these surveys, because of available information. Also, much information was obtained from V. Hawley, (CWS) concerning Bluenose herd barren-ground caribou calving areas, and from Dr. T. Barry, (CWS) on migratory waterfowl along the Arctic Coast.

The bulk of the information gathered as a result of field and library research appears on the forty-eight published map sheets. There, data are portrayed spatially, with an accompanying narrative, to denote critical and important habitat, population characteristics or species functions. Supplementary information on research methods and field observations is included in this report.

1.3 Summary of Observations

The following tables summarize a number of observations on the basis of species and wildlife zones:

Figure 1: Outline of Great Bear Lake and Great Slave Lake Study Areas

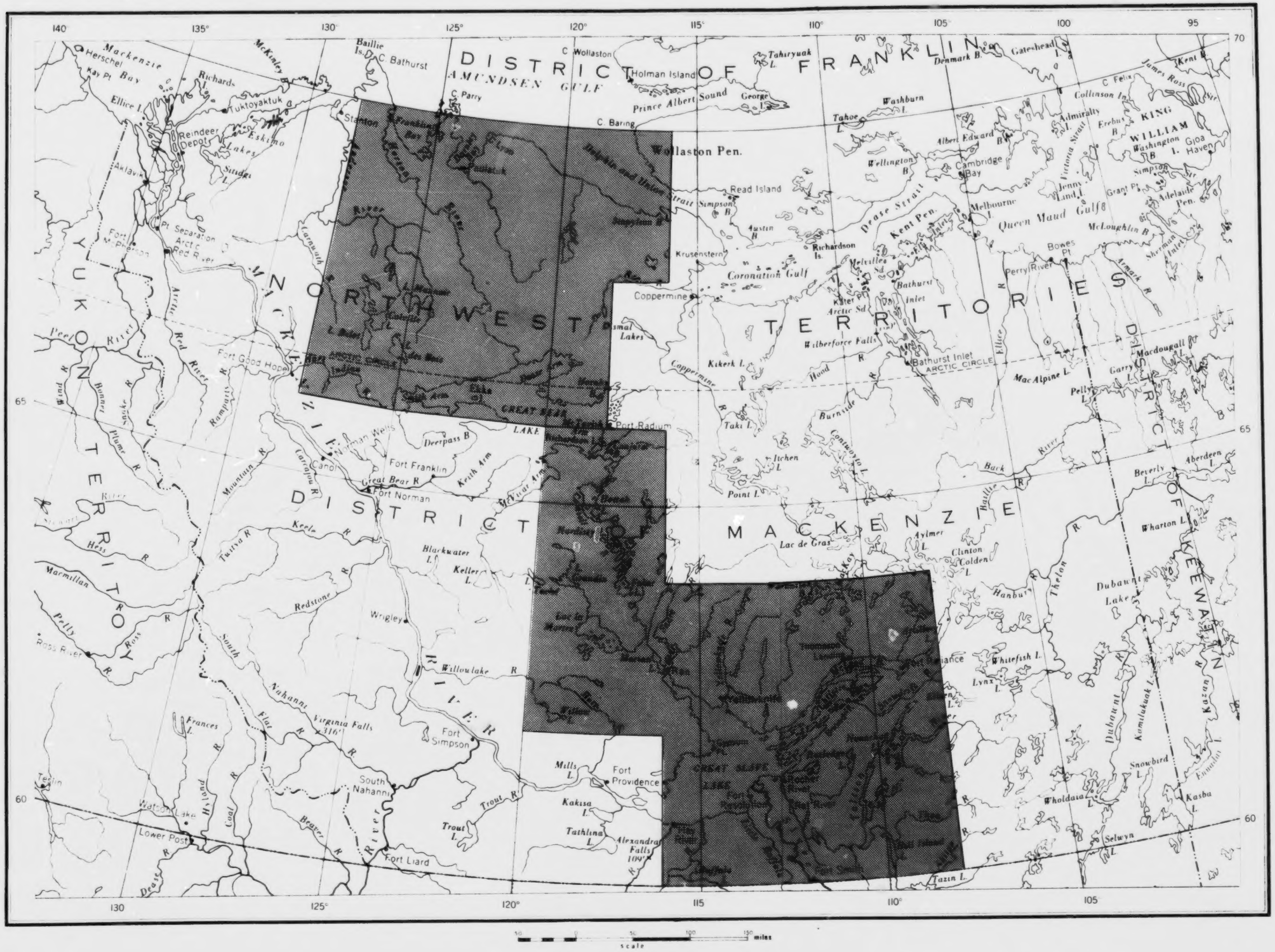
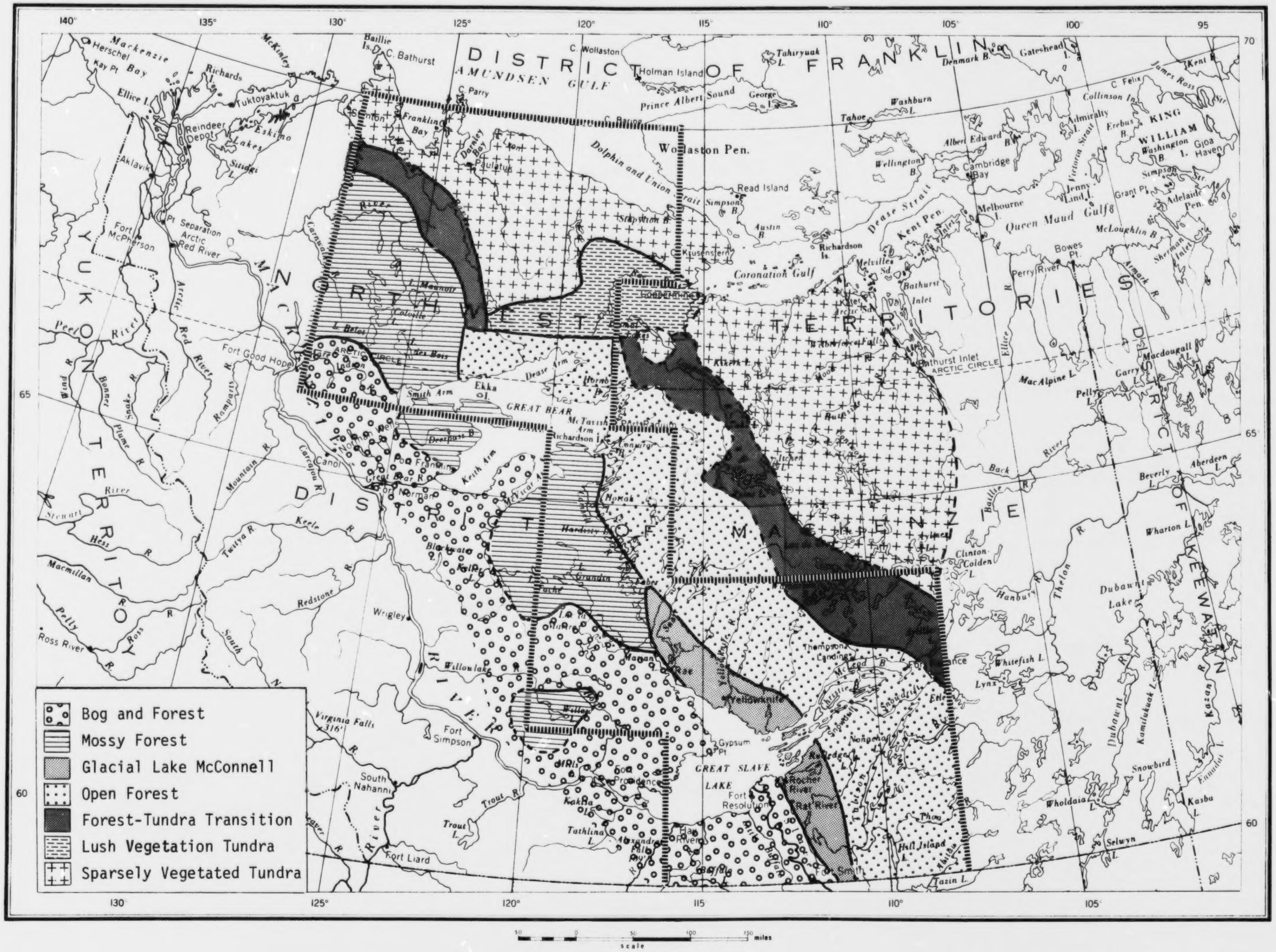

DISTRICT OF FRANKLIN
NORTHWEST TERRITORIES
DISTRICT MACKENZIE
YUKON TERRITORY
DISTRICT OF KEEWATIN
AMUNDSEN GULF
Coronation Gulf
Queen Maud Gulf
GREAT BEAR LAKE
GREAT SLAVE LAKE
ARCTIC CIRCLE
Coppermine
Port Radium
Fort Franklin
Fort Norman
Norman Wells
Fort Good Hope
Fort Simpson
Fort Providence
Fort Liard
Wrigley
Aklavik
Tuktoyaktuk
Cambridge Bay
Bathurst Inlet
Wollaston Pen.
Prince Albert Sound
Holman Island
Lac de Gras
Aylmer L.
Clinton Colden L.
Dubawnt Lake
Mackenzie River
140°
135°
130°
125°
120°
115°
110°
105°
100
95
70
65
60
scale
miles

TABLE 1 - Summary of Wildlife Observations

Species	Range in Study Area	Habitat Notes	Population and Behavior Notes
Moose	- forested portion	- river valleys provide important winter habitat on the Shield - fires appear to locally influence populations	- abundance depends on major ecosystem types. - forests of sedimentary plain - former Glacial Lake McConnell - open forest of Canadian Shield
Barren-ground caribou		- most open forest and all shield woodland provides winter range	
a) Bluenose herd	- N. of Great Bear Lake	- winter range	- Study area includes calving grounds and migration routes for the Bluenose herd and portions of migration routes for the Bathurst and part of the Beverly herd - fire appears to adversely affect winter range use
b) Bathurst herd	- between Great Bear and Great Slave lakes	- large forest area provides winter range	
c) Beverly herd	- S.E. of Great Slave Lake	- forest area provides part of herd's winter range	
Woodland Caribou	- All forest on sedimentary plain, S. & W. of Great Bear Lake.	- year round habitat	- some seasonal migrations apparent - some calving areas used annually
Bison			
a) Plains-wood bison	- immediately S. of Great Slave Lake.	- habitat of both bison populations is an extension of the ecosystem of the northern part of Wood Buffalo National Park	- some very distinct differences between the two bison populations
b) Wood bison	- immediately W. of Great Slave Lake.		
Muskox	- N. of Great Bear Lake	- tundra	- some herds are very large
Bears			
a) Black	- throughout forested portion		- locally abundant in the sedimentary plain forests along sandy river systems of the shield during spring
b) Grizzly	- common throughout entire forest-tundra and tundra portions	- Spring: appear to concentrate in major river valleys - Summer: range widely, including well into the forest.	
Fox			
a) Red	- common throughout the forests and well onto the tundra	- locally abundant in willow areas in late winter	
b) Arctic	- throughout the tundra and well into the forests in winter	- den throughout the tundra, but several ecosystems have very abundant den sites	
Marten	- throughout the forested portion		- locally abundant in portions of the sedimentary plain forests, especially the Horn Plateau and N. & S. of Great Bear Lake

Lynx	- forests of the sedimentary plain and the Canadian Shield and the area of Glacial Lake McConnell		- locally abundant in the forests of the sedimentary plain and the area of Glacial Lake McConnell
Wolverine	- throughout the study area		
Muskrat, mink and beaver	- throughout the forested portion		- very abundant in the Slave River lowlands and delta - abundant in the area of Glacial Lake McConnell
Otter	- throughout the forested portion	- in winter, associated locally with river rapids which provide necessary feeding habitat	
Wolf	- throughout the study area, both forested and tundra portions	- prime denning habitat in the forest-tundra transition zone	- abundant in the Slave River lowlands, associated with bison - associated with moose in portions of the Glacial Lake McConnell area - locally abundant in barren-ground caribou winter range
Waterfowl			
a) Swans	- throughout the study area in spring, summer, and early fall		- locally abundant in some ecosystems N. of Great Bear Lake - fall staging in several areas (large numbers)
b) Geese and ducks	- throughout area in spring, summer and early fall		- summer nesting - heavy spring and fall staging
Raptors			
a) Eagles	- throughout area		- bald eagles common in the forested portions - golden eagles common on the tundra
b) Falcons	- in specific nesting habitats		- not common

FIGURE: 2 Location of Wildlife Zones


Bog and Forest
Mossy Forest
Glacial Lake McConnell
Open Forest
Forest-Tundra Transition
Lush Vegetation Tundra
Sparsely Vegetated Tundra
DISTRICT OF FRANKLIN
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
YUKON TERRITORY
AMUNDSEN GULF
GREAT BEAR LAKE
GREAT SLAVE LAKE
Coronation Gulf
Queen Maud Gulf
Dease Strait
ARCTIC CIRCLE
Wollaston Pen.
Holman Island
Prince Albert Sound
Cambridge Bay
Tuktoyaktuk
Reindeer Depot
Aklavik
Fort McPherson
Arctic Red River
Fort Good Hope
Fort Norman
Canol
Wrigley
Fort Simpson
South Nahanni
Fort Liard
Fort Providence
Fort Resolution
Fort Smith
Yellowknife
Gypsum Pt
Hay River
Coppermine
Paulatuk
Thompson Landing
Clinton-Colden L.
Bathurst Inlet
Dubawnt Lake
Baker Lake
Virginia Falls 316'
Ross River
140°
135°
130°
125°
120°
115°
110°
105°
100°
95
70
65
60
50
0
50
100
150
miles
scale

THE STUDY AREA

The large study area covered by the project (Fig. 1) consisted of a number of diverse ecosystems. The individual large ecosystems (wildlife zones) are briefly described below, from southwest to northeast (Fig. 2). The area is part of the tundra, forest-tundra, and open woodland, boreal bioclimatic divisions of Hare and Ritchie (1972). The wildlife zones generally are equivalent to the land regions or eco-regions of Tarnocai and Netterville (1976) in northern Keewatin, N.W.T.; of Mills (1976) in northern Manitoba; and of Oswald (1976) in the Yukon Territory.

2.1 Bog and Forest Wildlife Zone

This wildlife zone covers the area west of Great Bear Lake in the Hare Indian River vicinity, and from southwest of Great Bear Lake to west and south of Great Slave Lake. It includes the area between the Horn and Cartridge plateaus, the Mackenzie Bison Sanctuary, and the area adjacent to Wood Buffalo National Park in the Northwest Territories.

Numerous shallow lakes, large bogs, and extensive spruce and jackpine forests characterize this zone. Terrestrial and arboreal lichens are abundant in the mature spruce stands, and large sedge meadows and willow-sedge parklands surround the shallow lakes. This wildlife zone provides good habitat for moose, woodland caribou, wood bison, black bear and geese. Most forest and aquatic furbearers can be found here (Plate 1).

The Slave River plain and delta, with their many sloughs, ponds, and old channels, is possibly the most productive portion of this wildlife zone, and was identified separately on the published maps. Vegetation is very diverse, ranging from prairies to aspen parkland to dense spruce forests. This is a unique part of the sedimentary plain bog and forest wildlife zone. The delta is abundant with muskrats and other aquatic furbearers and ducks. Plains-wood bison, moose, wolves, black bears, lynx and forest furbearers are abundant throughout the area.

2.2 Mossy Forest Wildlife Zone

Extensive spruce forests with many lakes and, where unburned, a relatively deep carpet of mosses and lichens, characterize this wildlife zone. Burned areas are common. Rivers tend to be dark in color. Much of the area is underlain by a gravelly moraine. This ecosystem extends northwest of Great Bear Lake, southwest of the Anderson River valley, and includes several large lakes; Colville, Aubrey, and Maunoir. South of Great Bear Lake it extends to west of Hottah Lake to include the Lac Grandin area and southwest to include the Cartridge Plateau. This is also the ecosystem of the Horn Plateau.

Moose and marten are abundant and barren-ground caribou use this area for winter range. Black bears are very common, and wolverine, red fox and most forest and aquatic furbearers can be found throughout the zone. Wolves and grizzly bears are often found here and many swans, geese and ducks use this area from spring through fall (Plate 2).

Plate 1 Bog and forest wildife zone, south of Lac la Martre

Plate 2 Mossy forest wildlife zone, north of Colville Lake.

2.3 Glacial Lake McConnell Area Wildlife Zone

The area east of the lower Taltson River and northeast of Great Slave Lake, from lake level up to 260m (850 ft), is influenced by deposition from Glacial Lake McConnell. This area extends, on the Shield, north from Great Slave Lake to Faber Lake.

On the Canadian Shield, most lakes are rock-bordered and deep, and generally have spruce forest to the edge. In the area of Glacial Lake McConnell influence, the lakes and ponds generally have a border of willows. This adversely affects barren-ground caribou resting preference, hence winter range, but provides excellent moose winter range and beaver habitat. Lynx and red fox are locally abundant in winter (Fig. 3 and Plate 3).

2.4 Open Forest Wildlife Zone

The large open forest area southeast of Great Bear Lake to southeast of Great Slave Lake is prime barren-ground caribou winter range. Deep, rocky lakes and fast-flowing rivers occur throughout this wildlife zone. Although limited numbers of most wildlife species may be found here, its prime use is as barren-ground caribou winter range (Plate 4).

2.5 Forest-Tundra Transition Wildlife Zone

From northwest to southeast, along treeline, the 16-80 km (10-50 mile) wide transition zone provides habitat for many species commonly found in both tundra and forest. Vegetation common to both ecosystems can be found here. Wolves den in abundance in the sandy eskers of this transition zone. This zone varies according to fire history, elevation, and substratum (Plate 5).

2.6 Sparsely-Vegetated Tundra Wildlife Zones

North of Great Bear Lake, from the Anderson River watershed east to the Rae and Richardson river headwaters, and along the Arctic coast, the tundra is sparsely vegetated. Most tundra species occur, but few in any abundance. Muskox live year-round and barren-ground caribou calve in this wildlife zone (Plates 6 and 7).

2.7 Lush Vegetation Tundra Wildlife Zones

The headwaters of the Bloody and Haldane rivers and the Rae and Richardson rivers, and the river valleys, contain lush willow and sedge vegetation. This area has many muskox, Arctic fox dens, whistling swan nests and many other tundra wildlife species (Plate 8).

FIGURE 3: IDEALIZED CROSS-SECTION OF GLACIAL LAKE McCONNELL INFLUENCE ON FOREST ECOSYSTEMS

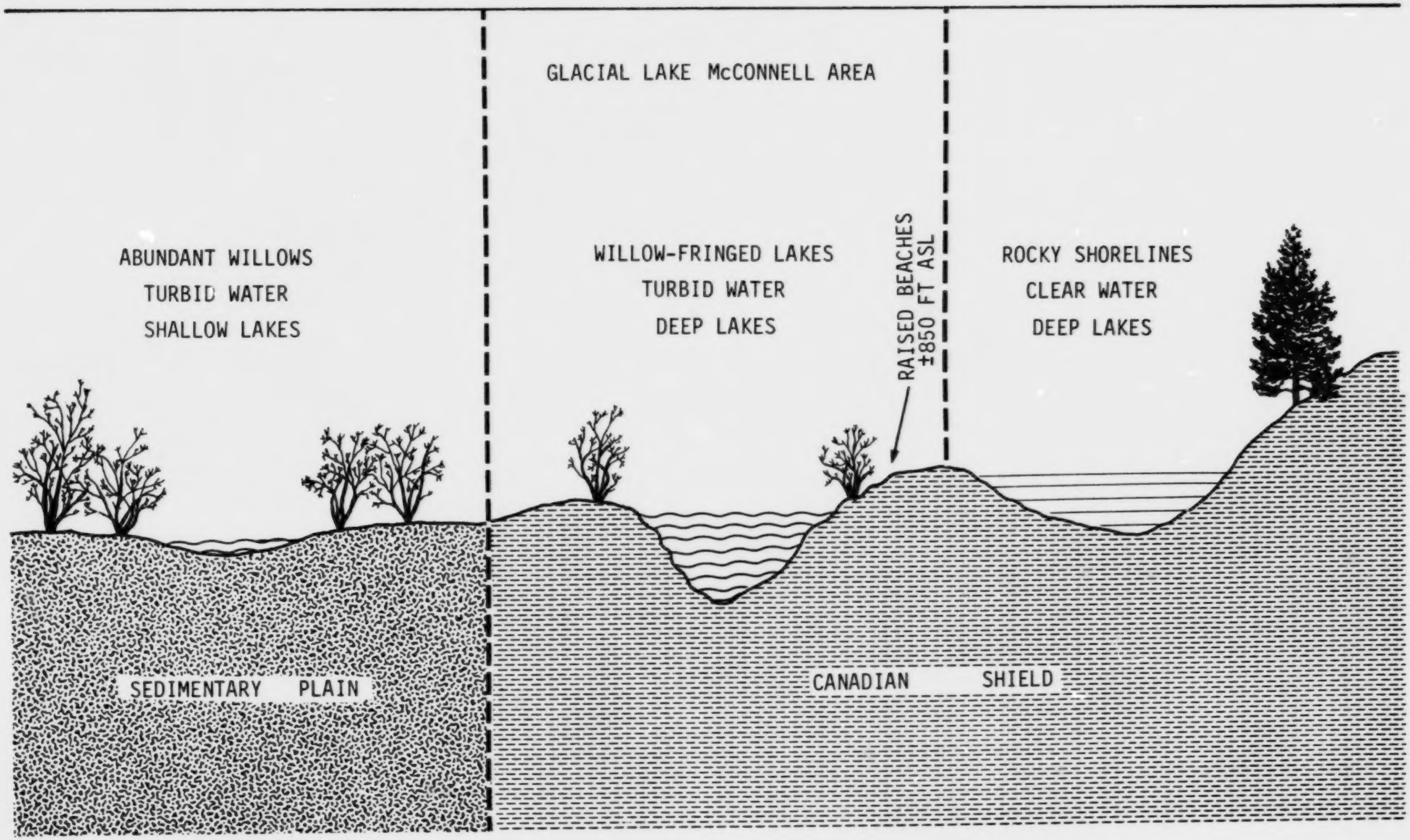

GLACIAL LAKE McCONNELL AREA
ABUNDANT WILLOWS
TURBID WATER
SHALLOW LAKES
WILLOW-FRINGED LAKES
TURBID WATER
DEEP LAKES
RAISED BEACHES
±850 FT ASL
ROCKY SHORELINES
CLEAR WATER
DEEP LAKES
SEDIMENTARY PLAIN
CANADIAN SHIELD

Plate 3 Glacial Lake McConnell wildlife zone near Ft. Rae

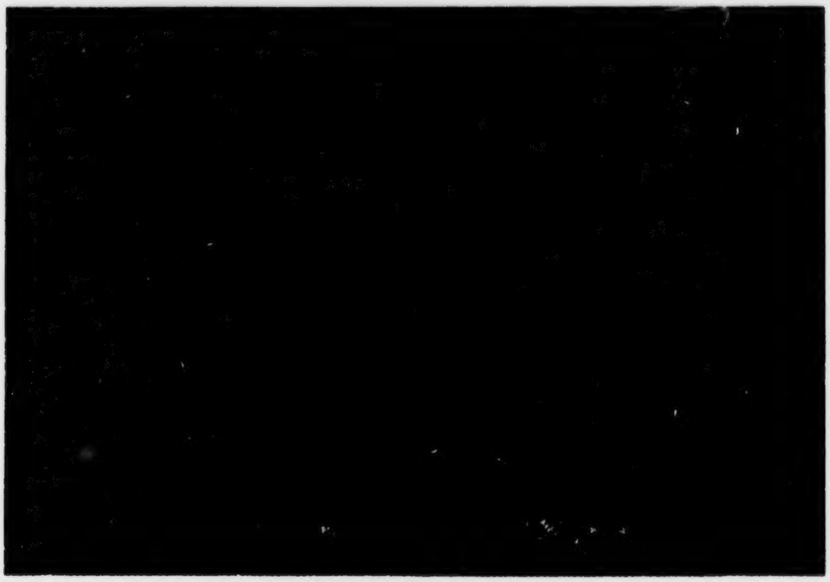


Plate 4 Open forest wildlife zone, northeast of Yellowknife

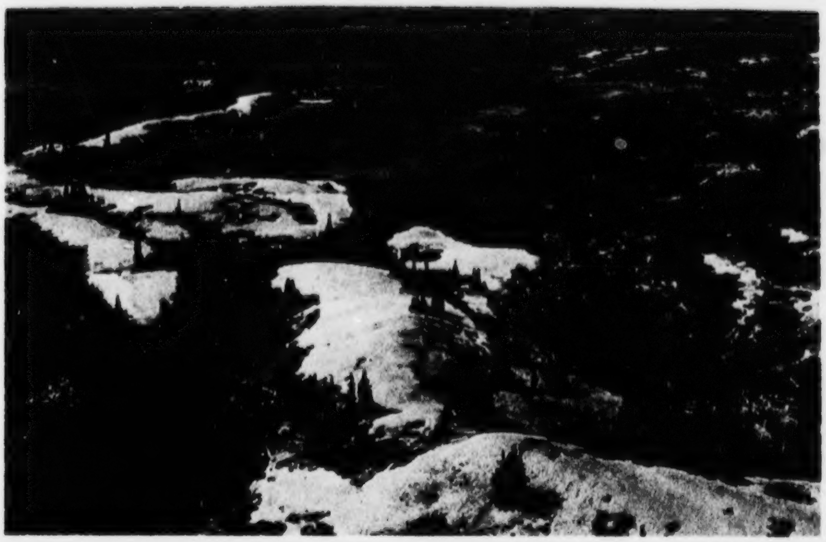


Plate 5 Forest-tundra transition wildlife zone, northeast of Beniah Lake, with a prime wolf-denning esker.

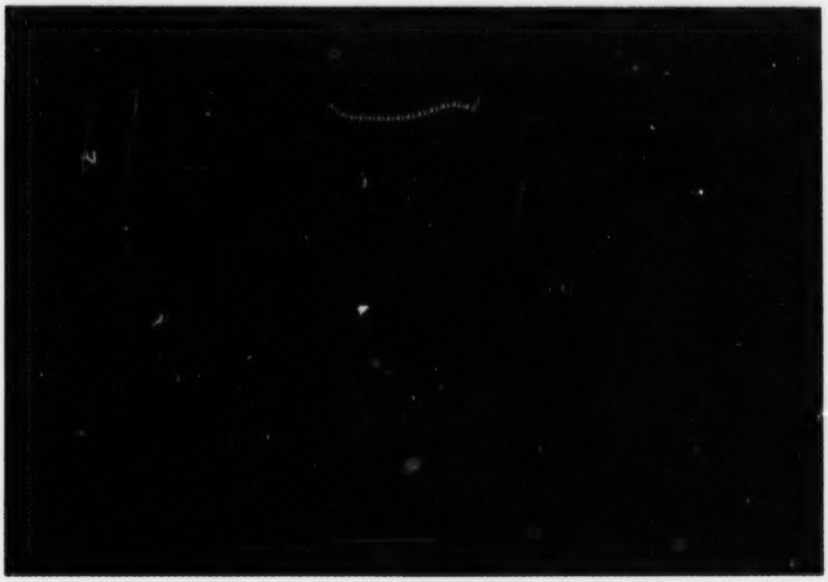


Plate 6 Sparsely-vegetated tundra wildlife zones, near Bluenose Lake

Plate 5 Forest-tundra transition wildlife zone, northeast of Beniah Lake, with a prime wolf-denning esker.

Plate 6 Sparsely-vegetated tundra wildlife zones, near Bluenose Lake

Plate 7 Sparsely-vegetated tundra wildlife zones, Hornaday River headwaters.

Plate 8 Lush vegetation tundra wildlife zones, Rae River valley.

RESEARCH METHODS

An identification of those areas important and critical to wildlife is one of the prime objectives of the mapping project. Year-round wildlife surveys provide much of the basic data. However, an extensive literature review and interviews with knowledgeable scientists and northern residents furnish additional, important information. The interpretation of aerial photographs and satellite imagery, combined with vegetation-landform studies, provides a basis for wildlife habitat evaluation.

3.1 Literature Review and Field Interviews

An area-specific, extensive literature review prior to field work is the logical first step in developing an understanding of an area. When combined with pertinent interviews with knowledgeable scientists and residents, the literature review has two obvious advantages: work previously completed will not be duplicated, and areas of potential importance or deficiencies of information can be identified.

The literature review is comprised of several components, loosely divided into an historical and an area-specific investigation and a natural history study of selected wildlife species. This review was initially planned as a many-week library task but is currently spread throughout the survey year, as are field interviews. From this in-depth pre-investigation of the survey area, an initial understanding of historical and recent wildlife observations, ecosystems, and specific species behaviour can be obtained and a preliminary wildlife map constructed.

The most important sources for pertinent literature or for knowledgeable sources for interviews are:

a) Canadian Wildlife Service Western Region Library, Edmonton (most wildlife sources)
b) Arctic Institute of North America Library, Calgary (formerly Montreal; most historical sources)
c) *Journal of Wildlife Management* (many individual species studies)
d) *Canadian Field Naturalist* (many area and ecological studies)
e) *Arctic* (many area studies)
f) Canadian Wildlife Service, Yellowknife and Edmonton (several very knowledgeable scientists)
g) Northwest Territories Wildlife Service, Yellowknife (several very knowledgeable scientists and local officers)
h) Local Hunters' and Trappers' Associations
i) Several Hudson's Bay Co. managers and free-traders
j) Some local pilots
k) Most Roman Catholic Priests (OMI)
l) Most old "white trappers"

Information from all of the above sources provided a strong foundation for subsequent surveys and description-writing. Several other sources provided information on specific topics.

The habitat work by Watson *et al.* (1973) and the Arctic Ecology Map Series, Descriptive Reports (1972) were very helpful. The descriptions by Beckel (1975) and Kelsall, Kuyt, and Zoltai (1971) were especially informative. Romaine (1974) and Kuchlov (1973) provided much help with the problems of ecological mapping. Bliss *et al.* (1973) and the Canadian Forestry Service (1974) helped classify ecosystems in the tundra and forest, respectively.

3.2 Landform - Vegetation Mapping

To provide a basis for evaluating habitat types, preliminary vegetation-landform maps were constructed from interpretation of aerial photographs and LANDSAT imagery. These maps incorporate standard geomorphic and vegetative classification. Several important functions are served by the landform-vegetation maps. Different ecosystems can often be delineated from these maps. In addition, specific habitats generally can be located. The investigator is then better able to locate habitats for specific wildlife functions.

In learning to interpret LANDSAT imagery several approaches were tried. Black and white images, both transparencies and prints, of various bands were tried. Colour composites, No. 1 and 2, were also tried, including 1:250,000 enlargements, color transparencies, and prints. These latter were the most informative for habitat boundary determination. Transparencies of the entire study area were examined at the Canada Centre for Remote Sensing in conjunction with Lands Directorate LUIS personnel. Specific examinations were made of some key areas. Lavigne and Falconer (1975) offer several successful examples of the use of LANDSAT imagery for habitat evaluation.

Several important sources for aerial photographs and LANDSAT imagery (including interpretaton) are:

a) National Air Photo Library, Department of Energy, Mines and Resources, Ottawa (complete Canada coverage)
b) Canada Centre for Remote Sensing, Ottawa (complete satellite imagery Canada coverage and interpretation aid)
c) Land Data and Mapping Branch, Lands Directorate, Environment Canada, Hull Quebec (very knowledgeable interpretation aid).

Information gained from the construction of landform, vegetation and habitat maps was used during all surveys and eventually was incorporated into the published maps.

3.3 Field Surveys

Aerial surveys are a very useful tool for wildlife mapping. Large areas can be covered repeatedly in a relatively short time. When combined with pertinent ground studies, aerial surveys provide a very accurate assessment of wildlife distribution, populations, and movements. Standard methods as detailed by Benson (1962) were used. Especially helpful were papers on survey techniques and problems, by Parker (1975), Caughley (1974), and Siniff and Skoog (1964).

A Cessna 185 was used for nearly all surveys. In conjunction with several camp or fuel cache moves, a DeHavilland Turbo-Beaver was used. The Cessna 185 is the ideal wildlife survey airplane for the Northwest Territories. It has a conservative 800 kilometre (500 mile) range, cruising at 210 kph (130 mph). On floats or skis it can utilize almost any lake for landing and take-off. Visibility is very good from the right seat and fuel consumption is less than 68 litres (15 gallons) per hour. The cost and cargo capacity even make it economical to place fuel caches with the 185 to increase survey range.

Survey coverage was based on a compromise between the size of the survey area, the amount of money available, and the species or habitats under survey. Coverage varied between 5 and 10 percent per survey based on a survey height of 180-240 m (600-800 ft) over forest or tundra, respectively. Air speed was generally 210 kph (130 mph) for most surveys, slower when appropriate.

Specific wildlife surveys were based on information gained from the literature, interviews, and the landform-vegetation maps and included surveys related both to individual species behavior and reconnaissance for unknown distributions or movements. Intensive surveys were conducted over some specific areas, generally for calving or population information, in conjunction with the normal surveys.

Ground investigation of selected typical (or unusual) areas is perhaps the most important component of the survey technique. Data which supports all techniques are found from numerous representative, ground investigations. Year-round multiple, ground investigations were made in all ecosystems and river systems. Murie (1954) offered great help in ground sign interpretation.

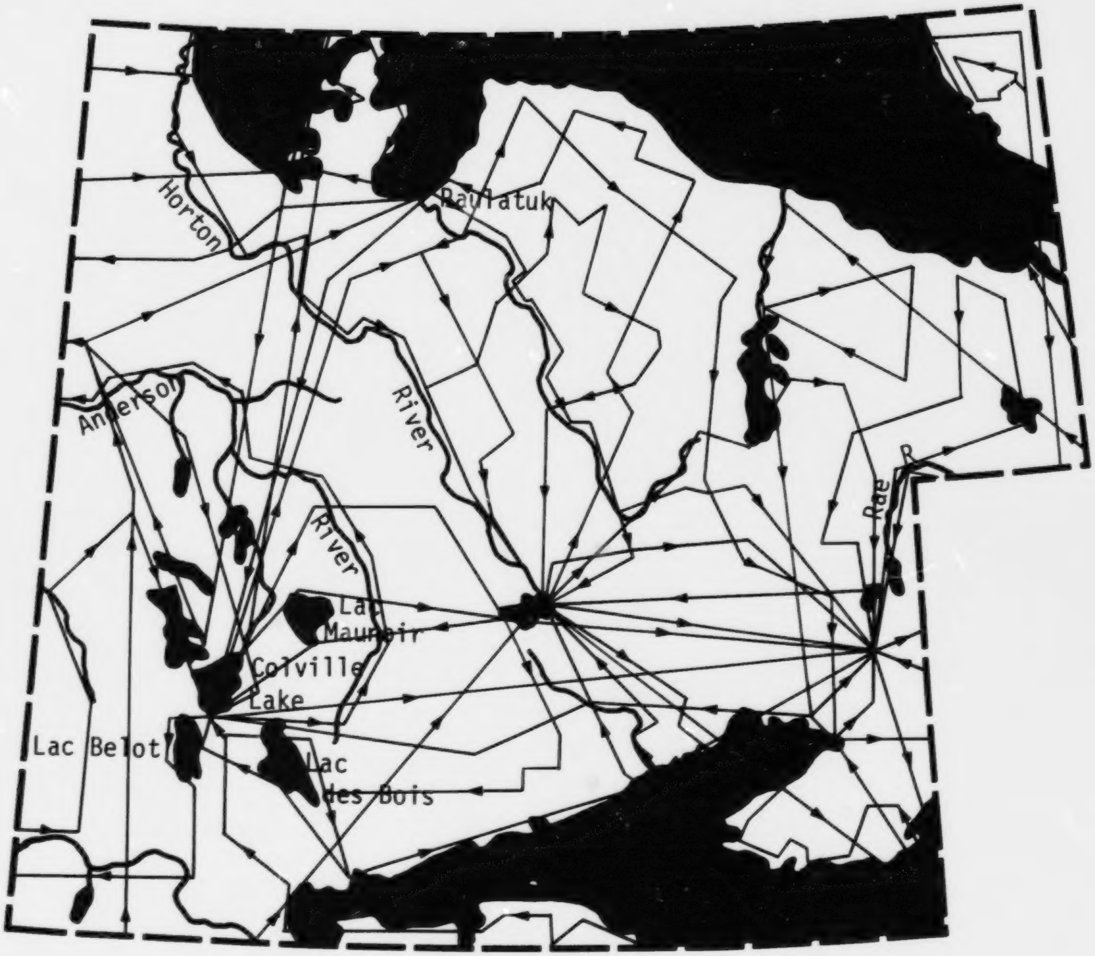
Accuracy of map data is a necessity. This requires accurate recording of wildlife sightings. With the pilot flying and observing, and the observer navigating, a notation system only slightly more complex than that required to jot down the position indication allows most information to be mapped at the time of observation, not much later (as is done when using a tape recorder to make notes).

A simple, yet complete notation system has greatest value if it is universal. Therefore, in devising a rapid recording system, existing symbols were used. These were the wildlife symbols in use on the LUIS Maps, the geologic and geomorphic symbols in standard use by the Geologic Survey of Canada, and vegetation classification symbols of the International Biological Program (Fosberg, 1967). Some memorization is required, but with regular use, this notation system is logical and practical. Two example survey map sections are illustrated in Figs. 4 and 5. A brief description of the survey notation system applicable to the study area can be found in Chapter 6.

3.4 Map Compilation

Preliminary data from the interviews and literature review were plotted on 1:250,000 maps. This information was analyzed and added to the landform-vegetation maps. Further, all information gained from surveys, whether for wildlife, vegetation, or geology, was analyzed and added to the base map. This mass of information was then standardized for content and described by narrative. The data were in some cases generalized to conform to the reconnaissance level of the map series. The final map product portrays a very accurate view of wildlife use of the area.

FIGURE: 4

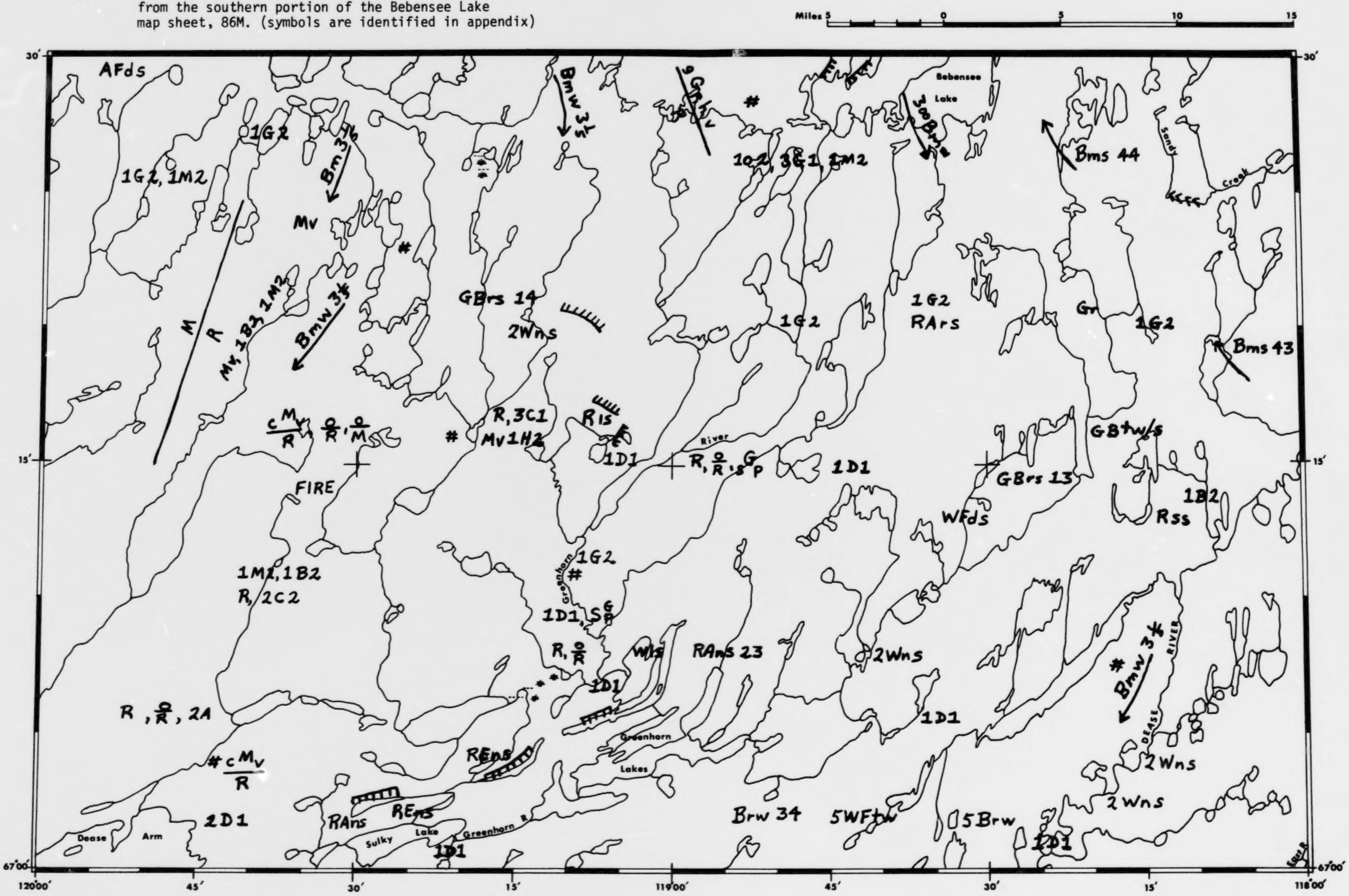

Horton
Paulatuk
Anderson
River
River
Lac Maunoir
Colville Lake
Lac Belot
Lac des Bois
Rae R.

Typical Survey Transect Coverage

—→— Flight Lines: July 1-Sept.1,1975

— — Study Area Boundary

Figure 5: Representative Field Map and Notations taken from the southern portion of the Bebensee Lake map sheet, 86M. (symbols are identified in appendix)


Miles 5 0 5 10 15
30'
AFds
1G2
1G2, 1M2
Bm 3½
Mv
M
R
Mv, 1B3, 1M2
Bmw 3½
Bmw 3½
GBrs 14
2Wns
9 Grhv
#
1o2, 3G1, 1M2
Bebensee
Lake
Bms 44
Sandy
Creek
1G2
RArs
Gr
1G2
1G2
Bms 43
R, 3C1
Mv1H2
Ris
River
R, o/R, s G/P
1D1
1D1
GBrs 13
GBtw/s
1B2
Rss
WFds
c Mv/R, o/R, o/M
FIRE
15'
1M1, 1B2
R, 2C2
Greenhorn
1G2
1D1, S G/P
R, o/R
W/s
RAns 23
2Wns
1D1
Bmw 3½
RIVER
DEASE
R, o/R, 2A
# c Mv/R
REns
Greenhorn
Lakes
2Wns
2Wns
2D1
RAns
REns
Dease
Arm
Sulky
Lake
Greenhorn R
1D1
Brw 34
5WFtw
5Brw
2D1
67°00'
120°00'
45'
30'
15'
119°00'
45'
30'
15'
118°00'

SURVEY METHODS, OBSERVATIONS AND DISCUSSION

The following wildlife species discussions provide detailed methods and observations supplemental to the information provided on the LUIS Maps.

4.1 Moose

Moose were assumed to be distributed throughout the forested region of the study area. Their distribution was thought to be affected by some seasonal, favorable habitat, such as areas of recent burns and shallow lakes during summer and along river valleys during winter. But aerial surveys for moose took two main forms. First, largely in conjunction with winter range surveys for barren-ground and woodland caribou, virtually all the forest area was surveyed several times each winter. Second, during late-spring through early fall general reconnaissance surveys were made throughout the study area, and especially along every major river valley, with repeated ground checks. All moose information was derived from these surveys.

4.1.1. Methods

Specific methods used to determine moose habitat utilization and presence varied by season. Following are descriptions of the survey techniques used.

a) Literature Review and Field Interviews

Notable as an excellent source of wildife information are the various NWT Wildlife Service (then Game Management Service) field reports. Many specific winter surveys have been flown for moose. They are especially useful as a test, overall, of the relative abundance of moose during winter, from area to area. Two very useful papers on moose distribution and survey techniques are Peek, Le Resche, and Stevens (1974) and Phillips, Berg and Siniff (1973). They discuss aggregations, movement patterns, and range use.

b) Winter Surveys

Because of time, cost, and personal constraints, and also to avoid duplication, winter moose surveys were, in large part, undertaken in conjunction with surveys for caribou, or occasionally bison. Many ground checks were made.

Specific moose signs were at times difficult to differentiate from caribou or bison tracks. Ground checks were made in these cases. Moose tracks along lake edges tended to be singular (or at most several sets: cow and calf). These tracks moved along from willow clump to willow clump, unlike the other large herbivores, caribou or bison. Moose winter cratering in grassy areas (sedge meadows) was often difficult to distinguish from that of caribou or bison.

c) Late-Spring through Early-Fall Surveys

Moose cryptic coloration is very good. Aerial observation during summer was almost strictly limited to spotting black or brown-colored moose against a bright green horsetail vegetation background, when the moose was feeding. They were seen both on reconnaissance flights and while surveying river valleys.

Additional important observations were made from the many ground checks. Moose droppings, if dry pellets, reflect winter woody feeding and, if wet and formless, reflect herb or grassy feeding. These many signs further aided moose observations, and an understanding of their habitat use.

4.1.2 Observations and Discussion

Moose appear to have a distinct winter range preference in these study areas and are very wide-ranging in summer. Following are descriptions of moose habitat use, by wildlife zone (ecosystem). Information about moose is generally all included on the LUIS maps. Fig. 6 illustrates moose relative abundance by wildlife zone.

LANDSAT imagery correlated very well with moose abundance in most areas. Apparently heavy silt content of the water was the significant spectral signature. Habitat boundaries were plotted relative to this signature in important areas.

a) Bog and Forest Zone

This large area contains a large moose population year-round. The abundant willows surrounding the innumerable shallow lakes and ponds provide excellent moose winter range. The summer semi-aquatic vegetation is lush. Moose are distributed throughout this wildlife zone year-round.

b) Mossy Forest Zone

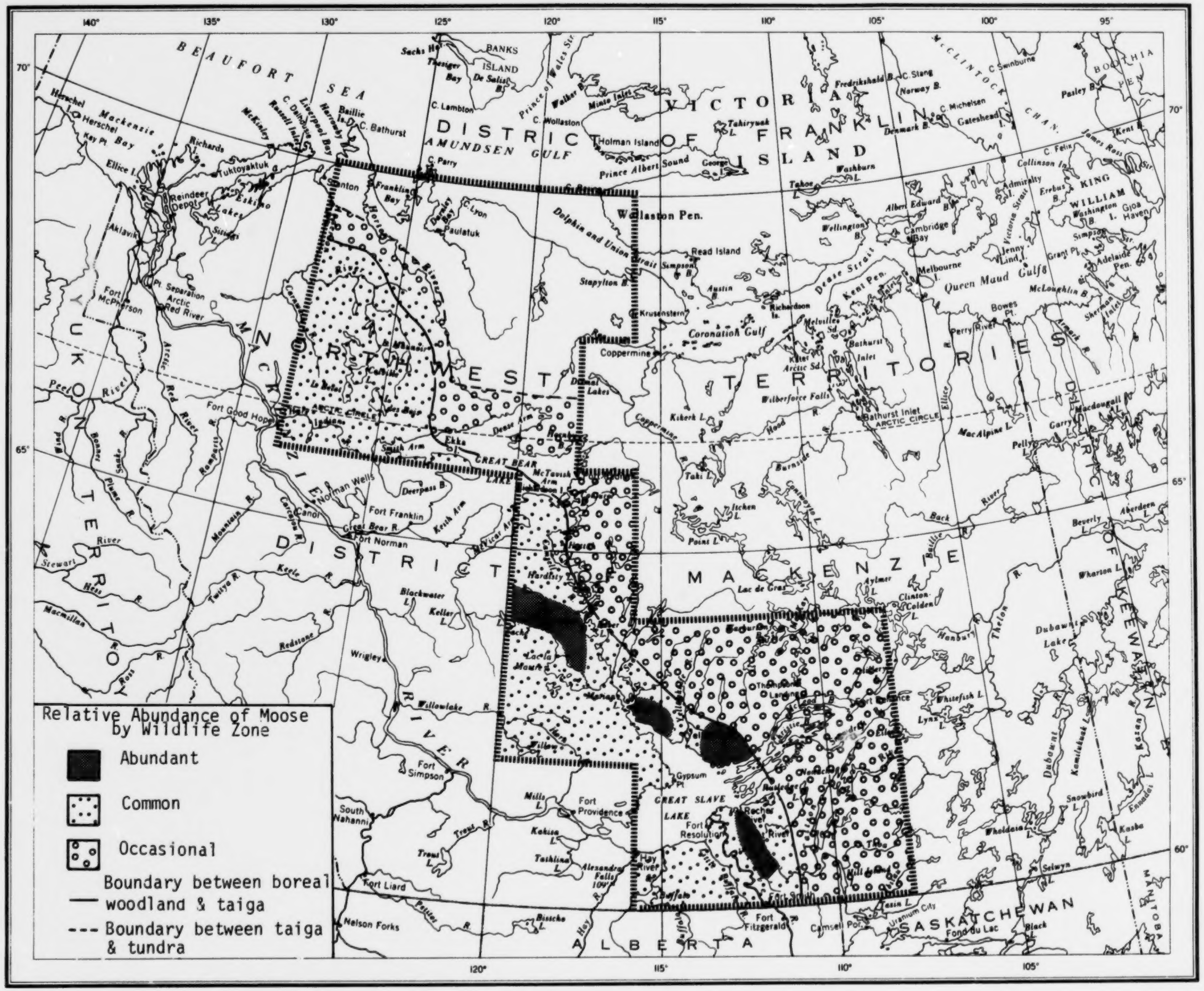
This extensive forest region provides good moose habitat. Moose may move into the ecotone adjoining the sedimentary plain bog and forest or the Glacial Lake McConnel areas during winter. Survey observations over three winters suggest this.

A second area of heavy moose winter concentration in this wildlife zone is on the steep slopes of the Horn Plateau. The many rapid flowing rivers provide plentiful riparian vegetation. The Slave River plain and delta portion of this wildlife zone also provides excellent year-round moose habitat. The riparian and semi-aquatic vegetation supports a very large moose population.

c) Glacial Lake McConnell Zone

The abundant willow fringes on the numerous lakes make this wildlife zone excellent moose winter range. The aquatic and semi-aquatic vegetation of the small lakes provides excellent summer range. Moose appear to move into this area each winter from the adjoining mossy forest and the open forest zones.

FIGURE:6


Relative Abundance of Moose by Wildlife Zone
Abundant
Common
Occasional
Boundary between boreal woodland & taiga
Boundary between taiga & tundra
BEAUFORT SEA
DISTRICT OF FRANKLIN
VICTORIA ISLAND
AMUNDSEN GULF
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
YUKON TERRITORY
GREAT BEAR LAKE
GREAT SLAVE LAKE
ALBERTA
SASKATCHEWAN
MANITOBA
Queen Maud Gulf
Coronation Gulf
ARCTIC CIRCLE
Fort Good Hope
Norman Wells
Fort Norman
Fort Franklin
Fort Simpson
Fort Providence
Fort Resolution
Hay River
Fort Smith
Fort Fitzgerald
Fort Liard
Coppermine
Aklavik
Fort McPherson
Tuktoyaktuk
Cambridge Bay
Wrigley
Uranium City
Fond du Lac
140°
135°
130°
125°
120°
115°
110°
105°
100°
95°
70°
65°
60°

d) Open Forest Zone

Moose can be found throughout this wildlife zone year-round, but are generally found in the numerous river valleys in winter, or adjacent to the semi-aquatic vegetation of lakes in summer. The riparian vegetation of the river valleys is maintained by annual flooding and ice-scouring during break-up.

A unique feature of this ecosystem is the succession through birch (in clusters with many stems), following fire, in the open spruce forest. This succession stage can be found throughout the study area, a result of the fire ecology of this forest. Moose can be found on these succession areas in relatively large numbers in early spring, browsing on the green shoots.

e) Forest-Tundra Transition Zone

Surprisingly, moose move far out onto the tundra during summer. Perhaps they follow the wooded river valleys. They are common throughout the forest-tundra transition zone during summer.

4.2 Barren-ground Caribou

Barren-ground caribou use two of the wildlife zones extensively for winter range, calve in another, and pass through two more on annual migrations. Surveys for barren-ground caribou initially covered forest areas during winter, and later extended winter surveys onto portions of the tundra. Summer surveys north of Great Bear Lake supplemented calving and migration work on the Bluenose herd by V. Hawley, CWS.

4.2.1 Methods

Specific methods used to determine barren-ground habitation utilize and presence varied by season. Following are descriptions of the various survey techniques.

a) Literature Review and Field Interviews

By far the most definitive work about caribou is Kelsall's (1968) study. Initially his caribou data was plotted on a preliminary map and assumed to need minor further work. But initial winter surveys found different range distribution, as did subsequent ones; hence, routine aerial winter surveys were flown. Additional interesting work was done by Scotter (1967, 1976) on the winter diet and effects of fire on winter range of caribou. Banfield's (1954a, 1954b) excellent caribou research provided an historical base.

b) Winter Surveys

The region encompasses the entire winter range of the Bluenose and Bathurst barren-ground caribou herds and a portion of the range of the Beverly herd. As part of the study, these herds were surveyed on their winter range at the following times:

Bluenose Herd (west of Horton Lake)

November, 1974
February, 1975
November, 1975
January, 1977

Bluenose Herd (east of Horton Lake)

March, 1974
March, 1975
March, 1976

Bathurst Herd

March, 1974
January, 1975
March, 1975
March, 1976
March, 1977

Beverly Herd (west of 108^{0}W)

March, 1974
February, 1975
March, 1976

All surveys were flown using ski-equipped Cessna 185 aircraft. Transects were 32 km (20 mi) apart, generally within tree line, and at 240 m (800 ft) above ground. Aircraft speed was 240 km/hr (150 mph).

Caribou tracks and/or numbers were noted, with movements if observed. Tracks were rated subjectively, according to an arbitrary scale, for abundance and freshness (Table 2). Dense concentrations, of barren-ground caribou on winter range, as mapped, indicate the two highest track classification on Table 2 (most and freshest) and estimated numbers of approximately 6 caribou/km^2 (10 caribou/mi^2 Plates 9 & 10 illustrate the use of the rating system.

c) Late-Spring through Early-Fall Surveys

Most specific migration and calving information about the Bluenose herd, the only herd calving in the study area, was obtained from V. Hawley, CWS. Migration information for the portion of the Beverly herd wintering in the study area was obtained from Kelsall and Kuyt's (1972) CWS publication. All caribou information regarding calving or migration is depicted on the LUIS maps.

Table 2. Classification of Caribou Tracks on Winter Range.

Rating	Abundance	Rating	Age
1	Very few	1	Very old
2	Few	2	Old
3	Some	3	Intermediate
4	Many	4	Fresh
5	Very many	5	Very fresh

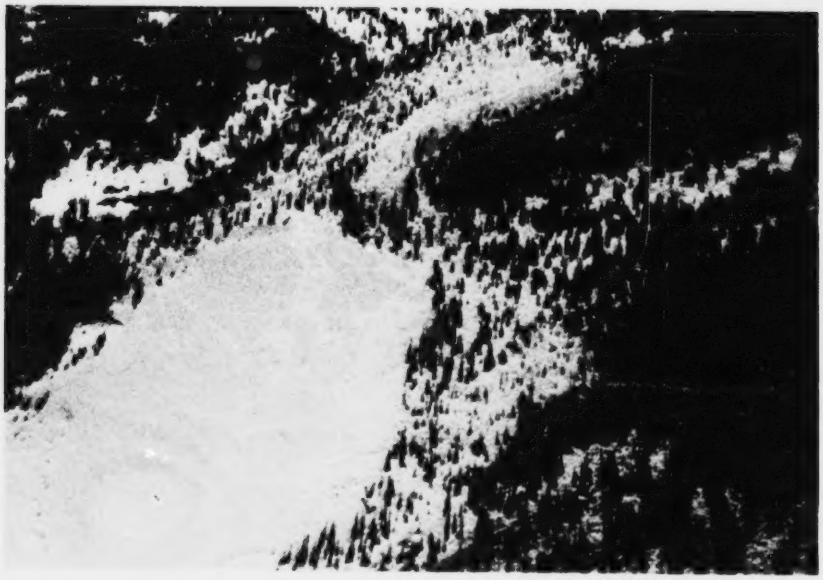


Plate 9 Barren-ground caribou sign, tracks and craters. This sign would be rated 5 (very many), 4 (fresh)

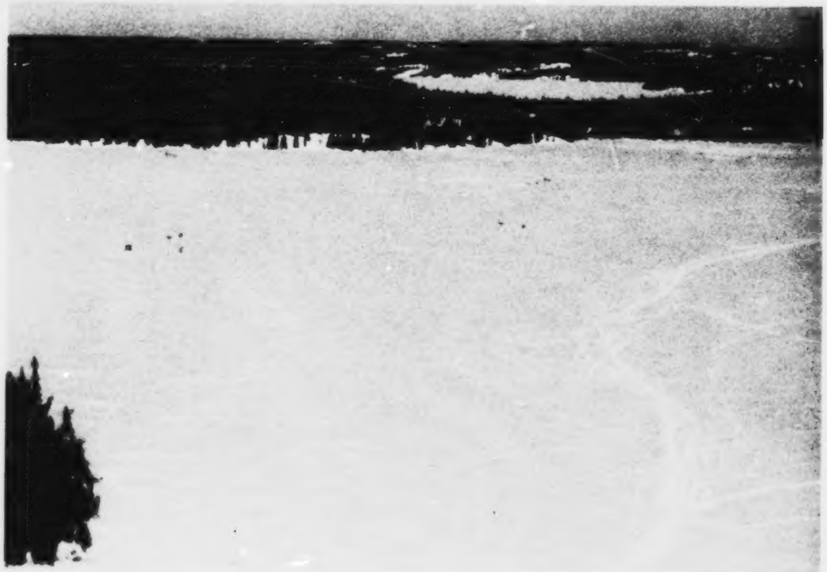


Plate 10 Barren-ground caribou observations and sign. A sample field notation for this observation would be 15 Brw 3,4 (15 barren-ground caribou estimated on winter range, plus some fresh sign).

4.2.2 Observations and Discussion

Barren-ground caribou used virtually all of the forest winter range during the four winters of study. Specific use is illustrated, in the sedimentary plain mossy forest, the Canadian shield open forest, the forest-tundra transition, and a portion of the tundra on the following maps listed by general area.

Summer range, north of Great Bear Lake, and migration routes are portrayed and described on the LUIS maps. Some migration routes for the Beverly herd, near the Snowdrift River, are also portrayed, with legend notes, on the LUIS maps.

a) Mossy Forest Zone

North of Great Bear Lake, much of the Bluenose herd winters generally in the area between the Anderson River valley, south to the vicinity of Colville Lake. Their actual distribution appears to vary both annually and during parts of the same winter.

Figs. 7 - 10 illustrate use of part of this wildlife zone as winter range. In mid-November 1974, a portion of the winter range was surveyed (Fig. 7), showing a concentration of caribou between the Lac Rendezvous-Tadnet Lake vicinity, south to Gassend Lake, and probably west to the Crossley Lakes vicinity. The caribou were moving westward.

During mid-February 1975, the herd distribution had shifted far eastward (Fig. 8), and ranged from the Carnwath River vicinity, eastward to Horton Lake.

In early November 1975 the dense caribou distribution was much further west (Fig. 9), centered around the forks of the Anderson River. Overall distribution was eastward, past Tsoko and Ewariege lakes and further south than in 1974, to Canot and Aubrey lakes.

In mid-January 1977, distribution of this portion of the Bluenose herd was again different (Fig. 10). During this period, the herd occupied virtually all of the winter range. The dense concentration was from the Anderson River, north of Simpson Lake, south to Colville Lake west. Overall distribution extended from west of Crossley Lakes, east to Estabrook Lake, and south to the Hare Indian River.

In the portion of barren-ground caribou winter range surveyed during mid-March 1974, mid-December 1975, and early-March 1976, caribou wintered in part of the sedimentary plain, mossy forest wildlife zone. This area is normally considered Bathurst herd winter range.

b) Open Forest

Surveys in mid-March 1974, showed a uniform, wide distribution of caribou on the surveyed portion of shield forest southeast of Great Bear Lake (Fig. 7). These were assumed to be Bathurst herd caribou.

Mid-March 1975 caribou distribution (Fig. 11) showed a uniform, but not dense occupation of this wildlife zone, which extends from approximately Hunters Bay southward. These were assumed to be Bathurst herd caribou.

Mid-December 1975 surveys showed a much less widespread distribution, more northerly, and with a distinct westerly movement north of Hottah Lake (Fig. 9). These were assumed to be Bathurst herd caribou.

The early-March 1976 distribution, as shown on Fig. 12 was very similar to the mid-March 1974 distribution, though a bit more northerly in this wildlife zone. There were two dense concentrations in this wildlife zone (south of Hunters Bay). These were east of Hottah Lake and south of Conjurers Bay. These latter caribou were not part of the Bathurst herd.

The movements depicted on Fig. 12 show the Hottah Lake concentration moving eastward, to calve east of Bathurst Inlet. The dense caribou concentration south of Conjurer Bay, however, moved directly north until past Hornby Bay, then moved northwest to the Bluenose Lake vicinity to calve, certainly an unusual movement. No caribou were found in the vicinity of the Bloody and Haldane rivers that year.

In the Great Slave Lake vicinity, barren-ground caribou distribution in the shield forest was composed of parts of two herds, the Bathurst and the Beverly herds. Distribution as shown on Fig. 7 shows a relatively uniform distribution in most of the open forest. Caribou north of Great Slave Lake generally were assumed to be of the Bathurst herd and to migrate northwards to calve. Caribou south of the lake were assumed to be generally of the Beverly herd and to migrate eastward to calve.

The mid-January 1975 caribou distribution was slightly different (Fig. 8). Two dense concentrations of caribou were found. One was centered around the east arm of Great Slave Lake and the other was generally between Porter and Thekulthili lakes. Both dense concentrations were probably Beverly herd caribou. Some Bathurst herd caribou were in the vicinity of Beniah Lake.

An interesting observation concerning the effects of fire on caribou winter range can be noted on Fig. 8. In the Thubun Lakes vicinity, caribou were observed moving into and turning back out from an area of burned forest. While the affects of the many types of forest fires on wintering caribou was beyond the scope of this study, a ground check of this area revealed that the ground cover lichens were completedly burned off, leaving only bare rock or earth. Less severe fires, which do not burn all of the lichen cover, do not seem to deter caribou movement to the same extent.

The early-March 1976 caribou distribution in this wildlife

FIGURE:7

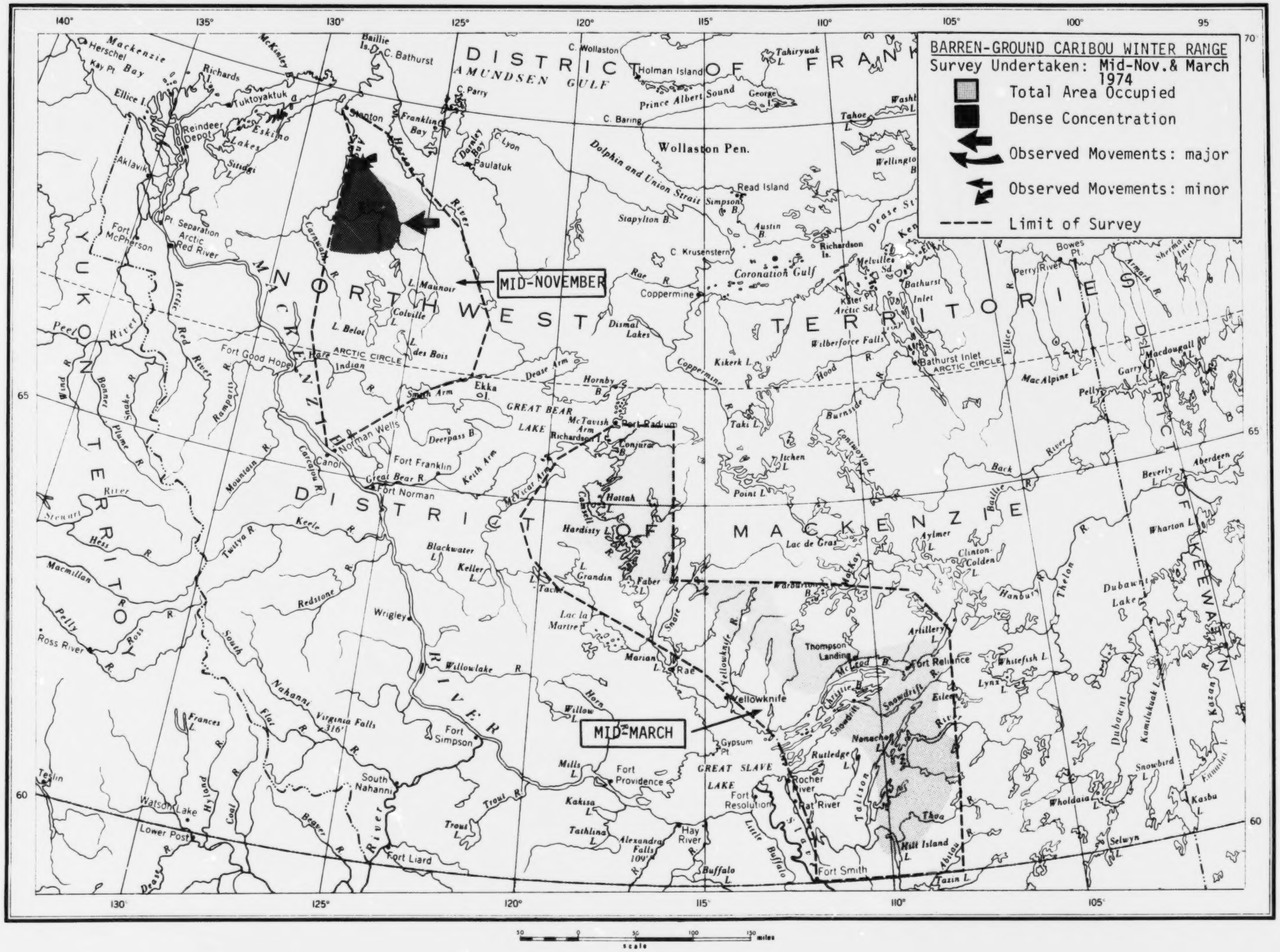
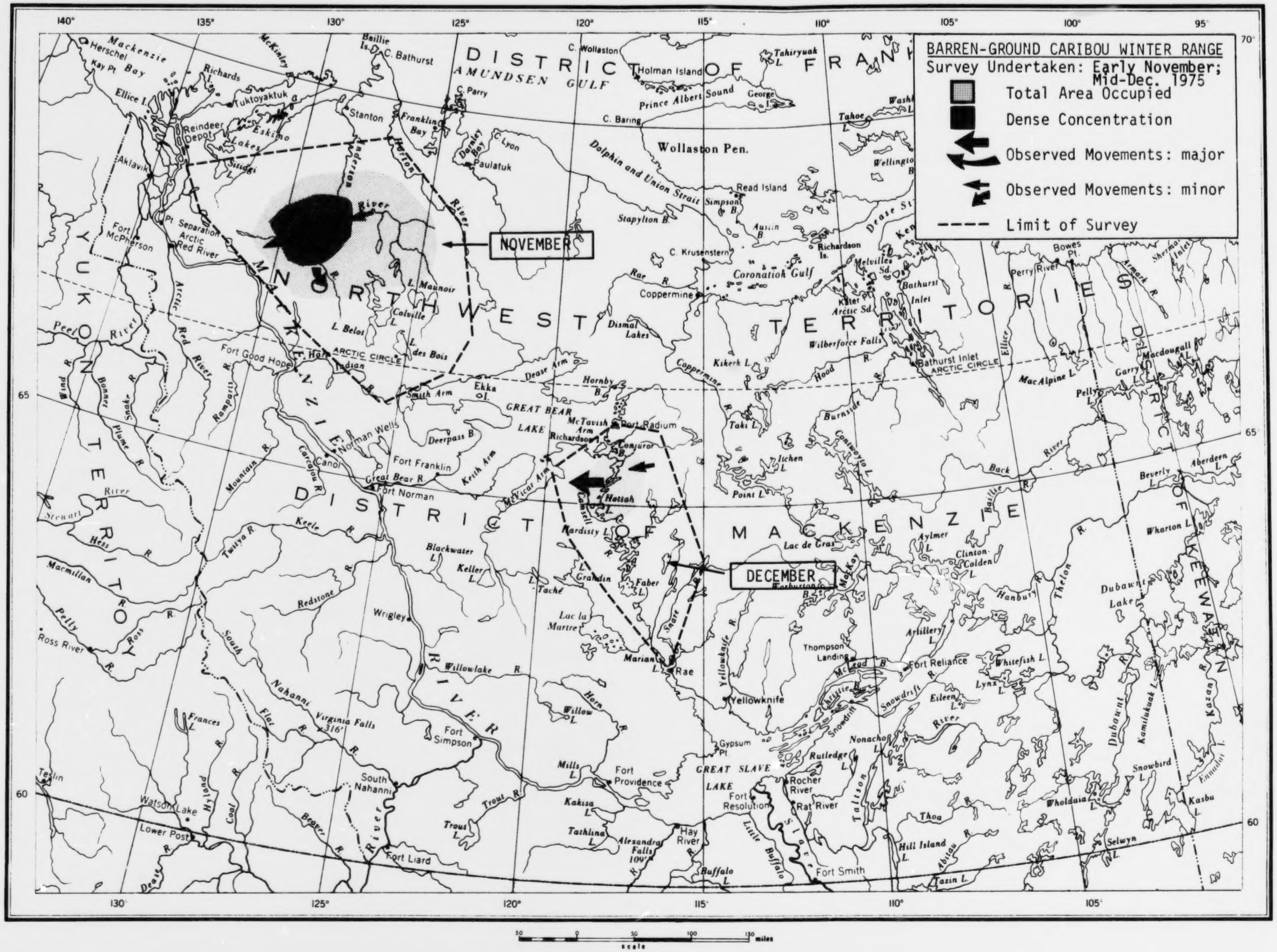

BARREN-GROUND CARIBOU WINTER RANGE
Survey Undertaken: Mid-Nov.& March 1974
Total Area Occupied
Dense Concentration
Observed Movements: major
Observed Movements: minor
Limit of Survey
MID-NOVEMBER
MID-MARCH
DISTRICT OF FRANKLIN
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
YUKON TERRITORY
GREAT BEAR LAKE
GREAT SLAVE LAKE
ARCTIC CIRCLE
50 0 50 100 150 miles
scale

FIGURE:8



BARREN-GROUND CARIBOU WINTER RANGE

Survey Undertaken: Early November; Mid-Dec. 1975

▨ Total Area Occupied

■ Dense Concentration

Observed Movements: major

Observed Movements: minor

---- Limit of Survey

NOVEMBER
DECEMBER
DISTRICT OF FRANKLIN
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
YUKON TERRITORY
MACKENZIE
AMUNDSEN GULF
GREAT BEAR LAKE
GREAT SLAVE LAKE
ARCTIC CIRCLE
Coronation Gulf
Wollaston Pen.
Dolphin and Union Strait
Prince Albert Sound
Tuktoyaktuk
Aklavik
Fort McPherson
Fort Good Hope
Norman Wells
Fort Norman
Fort Franklin
Port Radium
Coppermine
Paulatuk
Yellowknife
Rae
Fort Simpson
Fort Providence
Hay River
Fort Resolution
Fort Smith
Fort Reliance
Fort Liard
Watson Lake
Lac de Gras
Hottah
140°
135°
130°
125°
120°
115°
110°
105°
100°
95°
70°
65
60
scale
miles
50
0
50
100
150

FIGURE:8

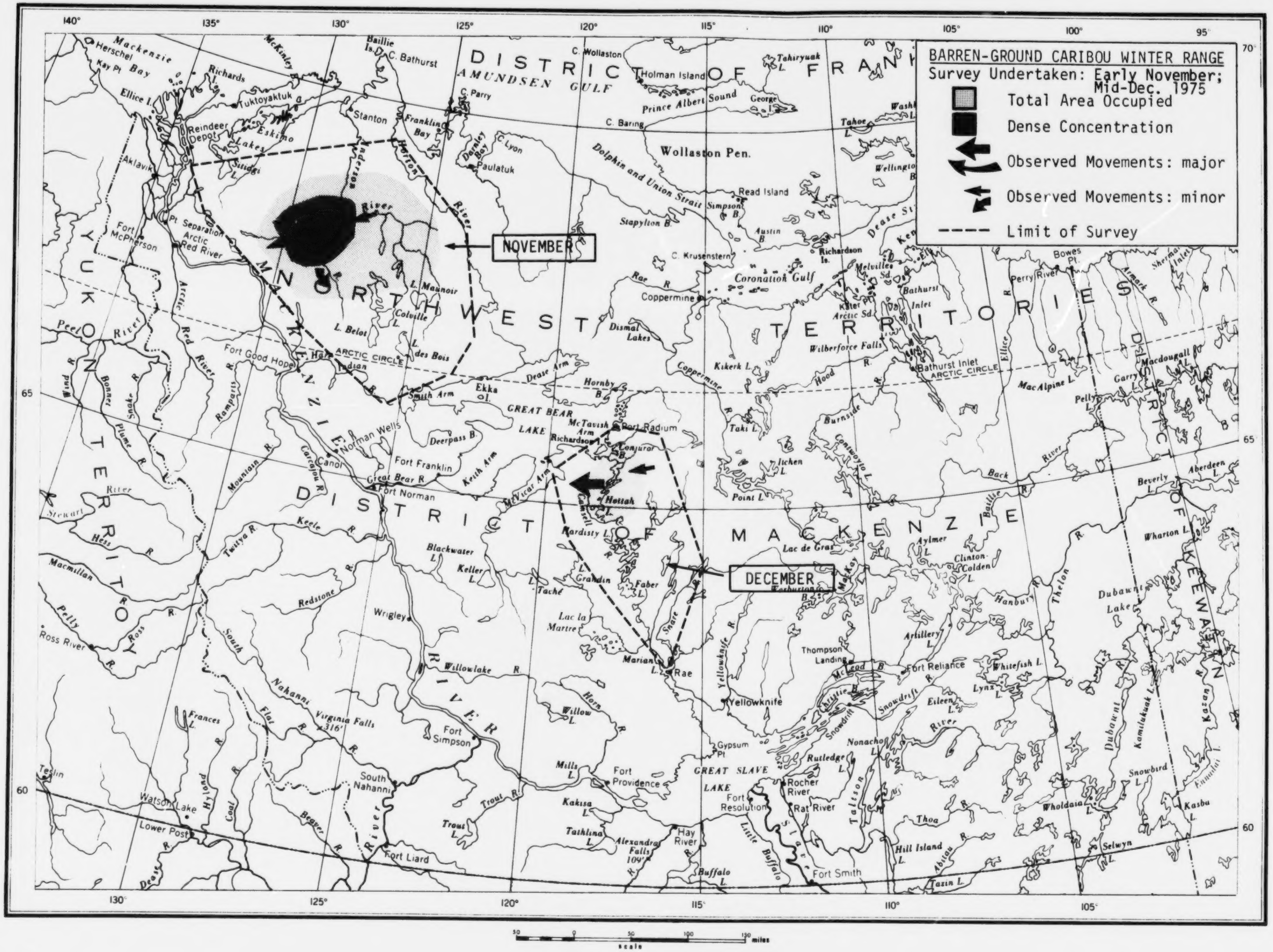

BARREN-GROUND CARIBOU WINTER RANGE
Survey Undertaken: Early November; Mid-Dec. 1975
Total Area Occupied
Dense Concentration
Observed Movements: major
Observed Movements: minor
Limit of Survey
NOVEMBER
DECEMBER
DISTRICT OF FRANKLIN
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
YUKON TERRITORY
AMUNDSEN GULF
GREAT BEAR LAKE
GREAT SLAVE LAKE
ARCTIC CIRCLE
Inuvik
Aklavik
Fort McPherson
Tuktoyaktuk
Paulatuk
Coppermine
Fort Good Hope
Norman Wells
Fort Norman
Fort Franklin
Port Radium
Rae
Yellowknife
Fort Simpson
Fort Providence
Hay River
Fort Resolution
Fort Smith
Fort Liard
Wrigley
140°
135°
130°
125°
120°
115°
110°
105°
100°
95°
70°
65°
60°
50
0
50
100
150
miles
scale

FIGURE: 9

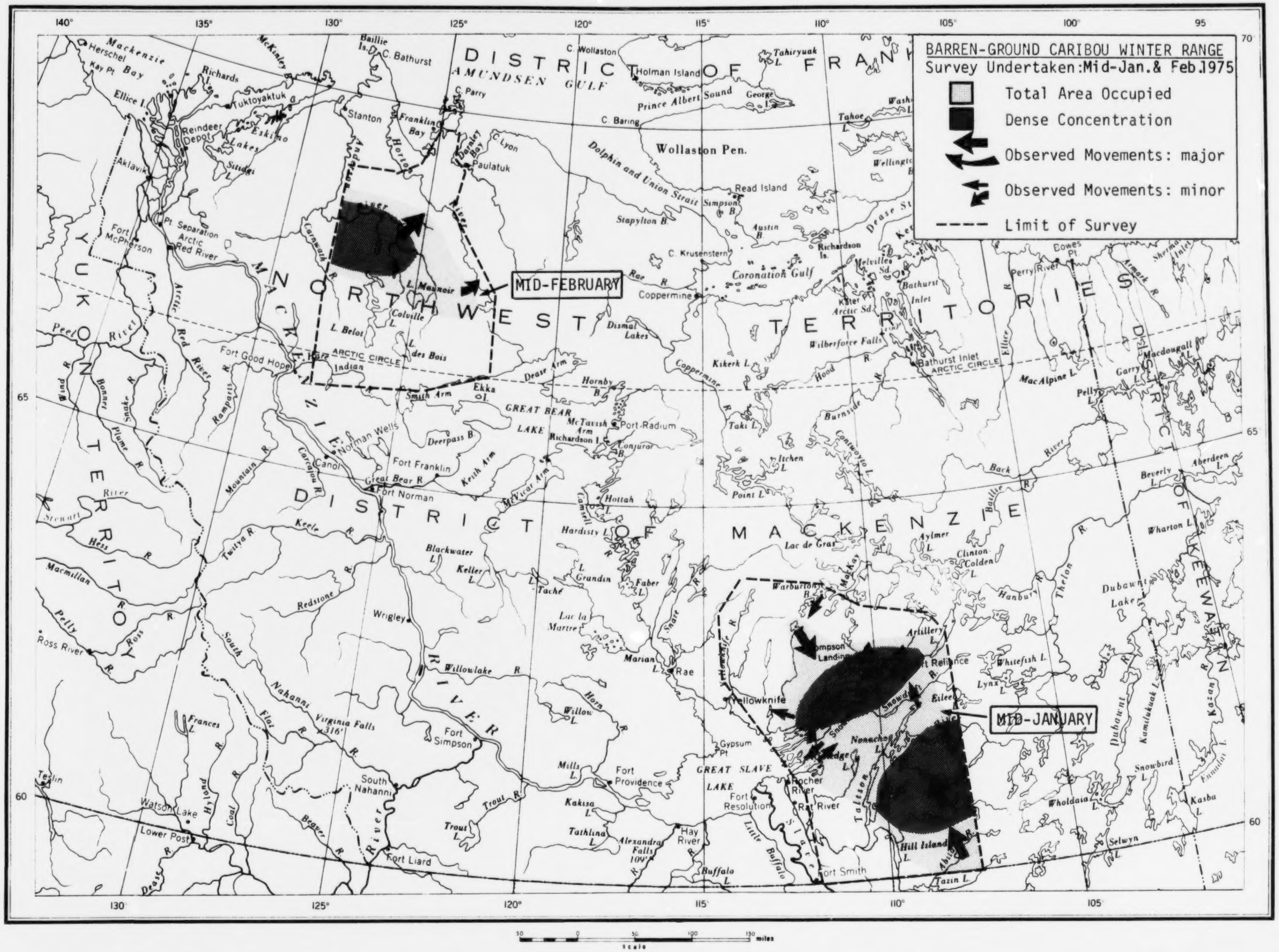
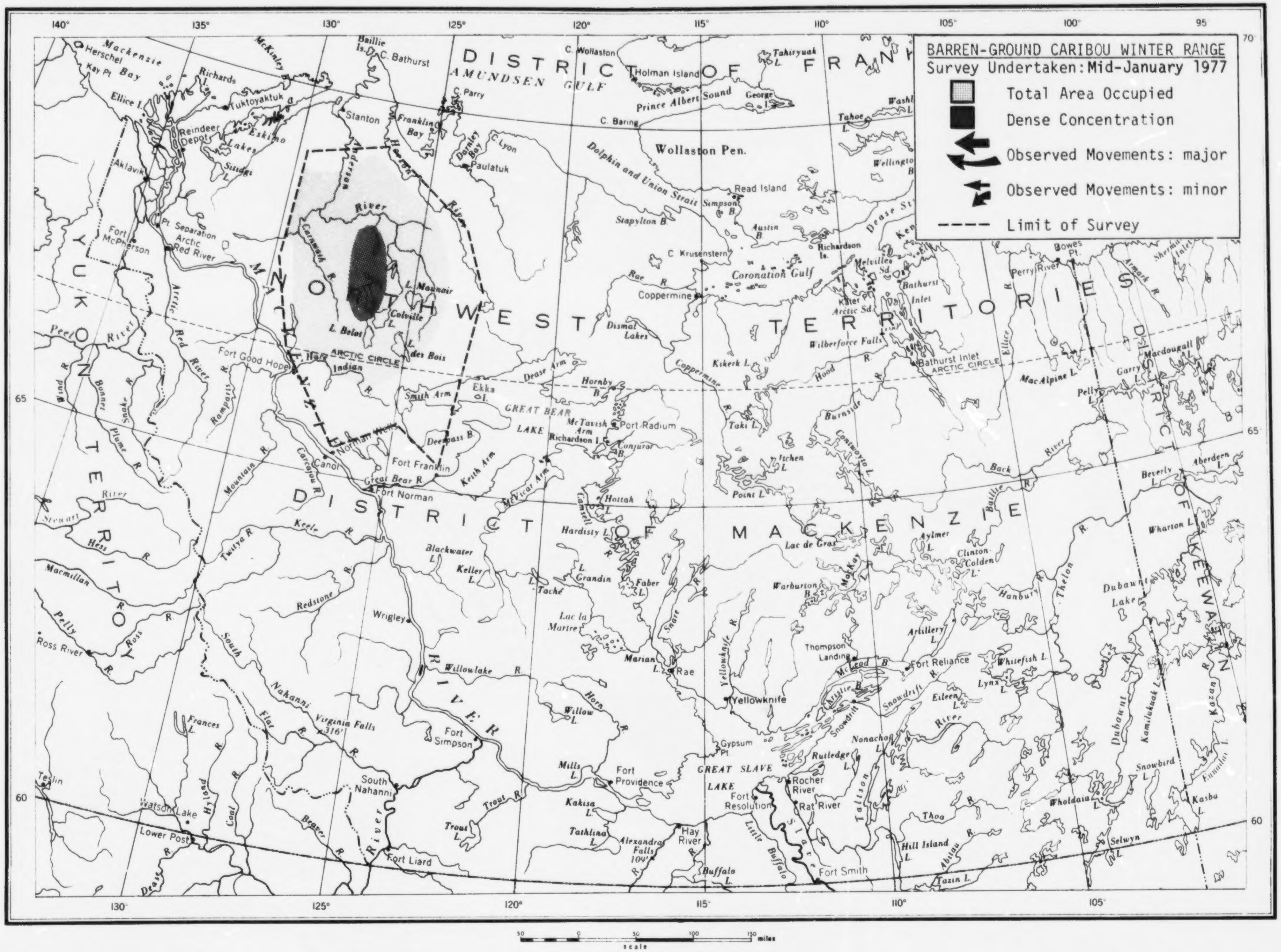

BARREN-GROUND CARIBOU WINTER RANGE
Survey Undertaken: Mid-Jan. & Feb. 1975
Total Area Occupied
Dense Concentration
Observed Movements: major
Observed Movements: minor
Limit of Survey
MID-FEBRUARY
MID-JANUARY
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF FRANKLIN
DISTRICT OF KEEWATIN
YUKON TERRITORY
AMUNDSEN GULF
GREAT BEAR LAKE
GREAT SLAVE LAKE
ARCTIC CIRCLE
Coronation Gulf
Wollaston Pen.
Prince Albert Sound
Dolphin and Union Strait
Holman Island
Paulatuk
Tuktoyaktuk
Aklavik
Fort McPherson
Arctic Red River
Fort Good Hope
Norman Wells
Fort Norman
Fort Franklin
Port Radium
Coppermine
Bathurst Inlet
Yellowknife
Rae
Fort Resolution
Fort Providence
Hay River
Fort Smith
Fort Simpson
Wrigley
Fort Liard
Snowdrift
Fort Reliance
Artillery L.
Nonacho L.
Hill Island L.
Tazin L.
Mackenzie R.
Back River
Thelon R.
Dubawnt Lake
140°
135°
130°
125°
120°
115°
110°
105°
100°
95
70
65
60
50 0 50 100 150 miles
scale

FIGURE:10


BARREN-GROUND CARIBOU WINTER RANGE
Survey Undertaken: Mid-January 1977
Total Area Occupied
Dense Concentration
Observed Movements: major
Observed Movements: minor
Limit of Survey
DISTRICT OF FRANKLIN
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
YUKON TERRITORY
AMUNDSEN GULF
GREAT BEAR LAKE
GREAT SLAVE LAKE
ARCTIC CIRCLE
Mackenzie Bay
Herschel
Kay Pt
Ellice I.
Richards I.
Tuktoyaktuk
Eskimo Lakes
Reindeer Depot
Aklavik
Fort McPherson
Pt Separation
Arctic Red River
Baillie Is.
C. Bathurst
Stanton
Franklin Bay
C. Parry
Darnley Bay
C. Lyon
Paulatuk
Anderson River
Horton River
L. Maunoir
Colville L.
L. Belot
L. des Bois
Fort Good Hope
Norman Wells
Fort Norman
Fort Franklin
Great Bear R.
Canol
Smith Arm
Dease Arm
Keith Arm
McVicar Arm
Port Radium
Coppermine
C. Wollaston
Holman Island
Prince Albert Sound
C. Baring
Wollaston Pen.
Dolphin and Union Strait
Read Island
C. Krusenstern
Coronation Gulf
Bathurst Inlet
Lac de Gras
Yellowknife
Rae
Fort Reliance
Fort Resolution
Fort Providence
Hay River
Fort Smith
Fort Simpson
Wrigley
South Nahanni
Fort Liard
Virginia Falls 316'
Alexandra Falls 109'
Watson Lake
Lower Post
Ross River
Teslin
Back River
Thelon
Dubawnt Lake
Aberdeen L.
Beverly L.
Kazan
Mackenzie River
Peel River
70
65
60
140°
135°
130°
125°
120°
115°
110°
105°
100°
95
scale
50
0
50
100
150
miles

zone (Fig. 12) was very similar to the mid-March 1974 distribution. Caribou of the Bathurst herd were generally in two groups. A large concentration was north of Yellowknife, between Ghost and Gordon lakes. A smaller group was in the forest north of the east arm of Great Slave Lake.

Southeast of Great Slave Lake, a small, but densely-concentrated, group of Beverly herd caribou was located near the Snowdrift River. A large, dense concentration of Beverly herd caribou was found between the Taltson and Thoa rivers and southeastward.

c) Forest-Tundra Transition Zone

Although the area immediately to the north of Great Bear Lake is described as part of the Open Forest Zone, it is really a complex area that incorporates many small areas which could be classed as part of the Forest-Tundra Transition Zone. Some caribou winter routinely in the forest-tundra transition wildlife zone. The Haldane and Bloody rivers, north of Great Bear Lake are winter range for part of the Bluenose herd (Fig. 11). In the whole area of Caribou Point, between Dease Arm and Hornby Bay, caribou from both the Bluenose and Bathurst herds winter (Fig. 11 and 12). Both places are historically annual caribou winter range.

d) Sparsely-Vegetated Tundra

Most caribou in the Bluenose herd were observed on their calving grounds in 1976. This information, plus general migration data, is depicted, with legends on the LUIS maps. Fig. 13 recapitulates this information.

e) Lush Vegetation Tundra

As depicted on Figs. 11 and 12, some barren-ground caribou winter on the tundra. These are both of the Bluenose and Bathurst herds. Historically, this is an annual occurrence between Caribou Point and Dismal Lakes. The mid-March 1975 barren-ground caribou winter range near Coppermine (Fig. 11) was apparently an unusual occurrence. These were caribou from the Bathurst herd.

A number of differences can be noted between the winter ranges most used during Kelsall's (1968) study and this one (Fig. 14 summarizes all ALUR winter range survey findings). The caribou winter range is now more northeast, often by more than 160 km (100 miles). Significantly, when also compared with Banfield's (1954a, 1954b) studies, the movements north and northeastward, from former maximum forest penetrations, are very noticeable. Fire or snow do not appear to be the reasons for this apparent shift in winter forest penetrations.

Barren-ground caribou range surveys are conducted very differently, depending upon the season. The following brief discussion will outline the salient features of each type of survey, by season.

a) Winter-range Surveys

The shortness of daylight and the intense cold make November through January surveys very difficult. Due to open water on the Arctic coast and on both Great Bear and Great Slave lakes, much freezing fog and snow is encountered. Ice is generally unsafe for lake landings during most of November. The low temperatures cause both engine and structural aircraft problems and breakdowns. Gas caches are often difficult to get to because of both weather and overflow. Flat light makes spotting of both caribou and tracks difficult.

Parallel flight lines should be flown throughout the active area of the herd's potential range. Tracks and sightings are noted. Analysis of the entire herd information can show movement (older versus newer tracks), abundance (few versus many tracks and animals), and concentration areas.

b) Summer Surveys

Two types of summer caribou surveys should be conducted. An initial calving ground survey should be flown in late-May to determine the extent of area used. In mid-June a survey should be flown in the same general area, to determine post-calving distribution. Normal summer reconnaissance surveys should disclose any significant bull summer ranges. Cryptic coloration is a problem with this species in summer, but tracks are readily observable in mud or sand and numbers are generally large.

c) Migration Surveys

July and April surveys, across migration routes, will disclose fall and spring migrations, respectively. In spring, the cows will lead the migrations. Bulls may often be a hundred miles down-route. Snow trails will lead the surveyor back to the last-occupied winter-range. Fall migration surveys are slightly more difficult, since the tracks are less apparent without snow. Sand and mud show recent tracks, easily observable from the air, and the herds are large.

4.3 Woodland Caribou

The bog and forest wildlife zones, south and west of Great Slave Lake, provide abundant, year-round habitat for woodland caribou. Specific and winter range migration surveys were flown for woodland caribou. Woodland caribou information was also obtained from wood bison surveys.

FIGURE:11

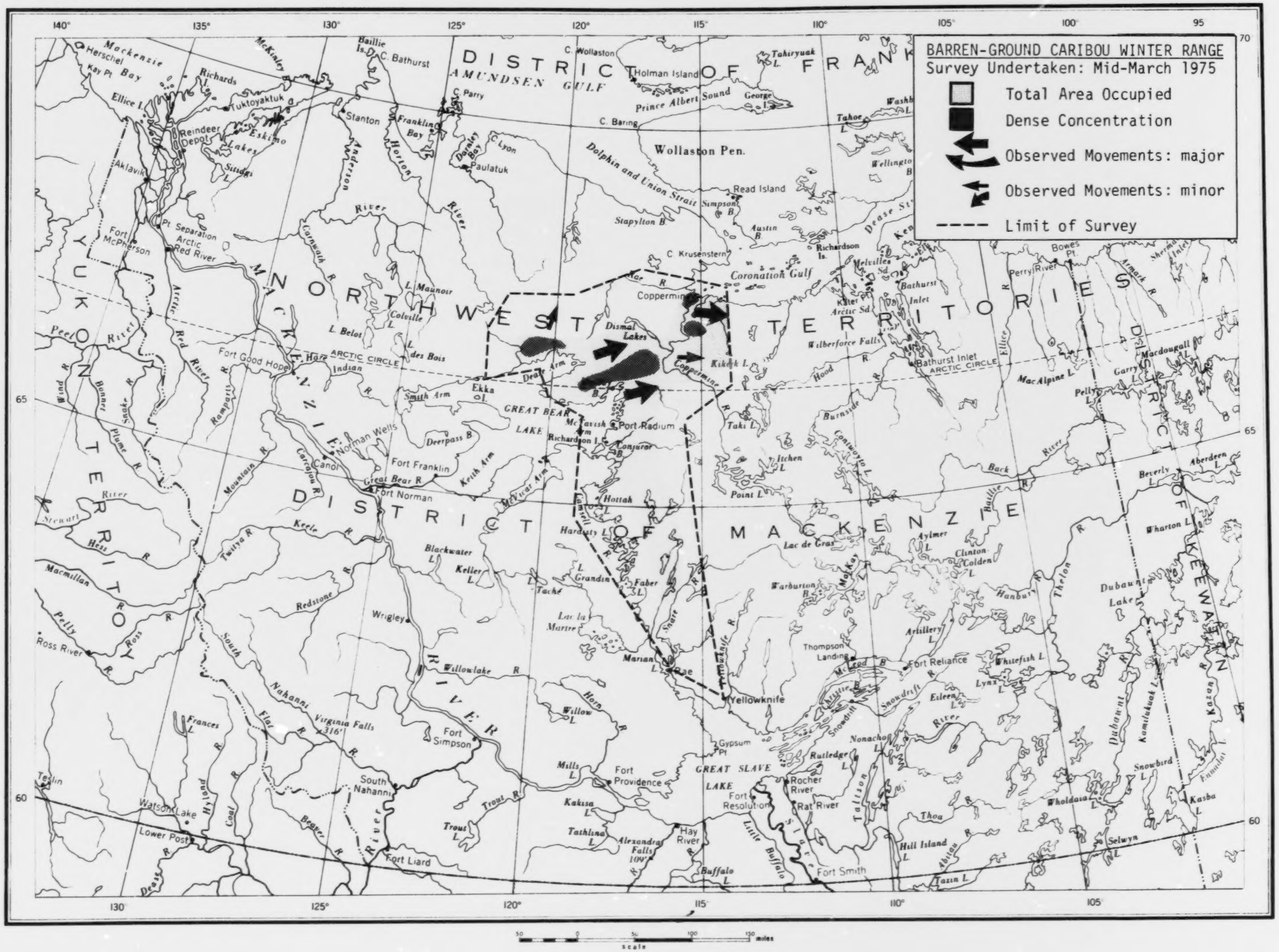

BARREN-GROUND CARIBOU WINTER RANGE
Survey Undertaken: Mid-March 1975
▢ Total Area Occupied
■ Dense Concentration
Observed Movements: major
Observed Movements: minor
----- Limit of Survey
DISTRICT OF FRANKLIN
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
YUKON TERRITORY
AMUNDSEN GULF
Coronation Gulf
GREAT BEAR LAKE
GREAT SLAVE LAKE
ARCTIC CIRCLE
Wollaston Pen.
Dolphin and Union Strait
Coppermine
Dismal Lakes
Dease Arm
Port Radium
Yellowknife
Rae
Fort Rae
Fort Providence
Fort Resolution
Fort Smith
Fort Simpson
Fort Norman
Fort Franklin
Fort Good Hope
Norman Wells
Aklavik
Tuktoyaktuk
Fort McPherson
Fort Liard
Wrigley
Hay River
Fort Reliance
Lac de Gras
Contwoyto L.
Mackenzie River
Back River
140° 135° 130° 125° 120° 115° 110° 105° 100° 95°
70 65 60
scale
miles
50 0 50 100 150

FIGURE:12

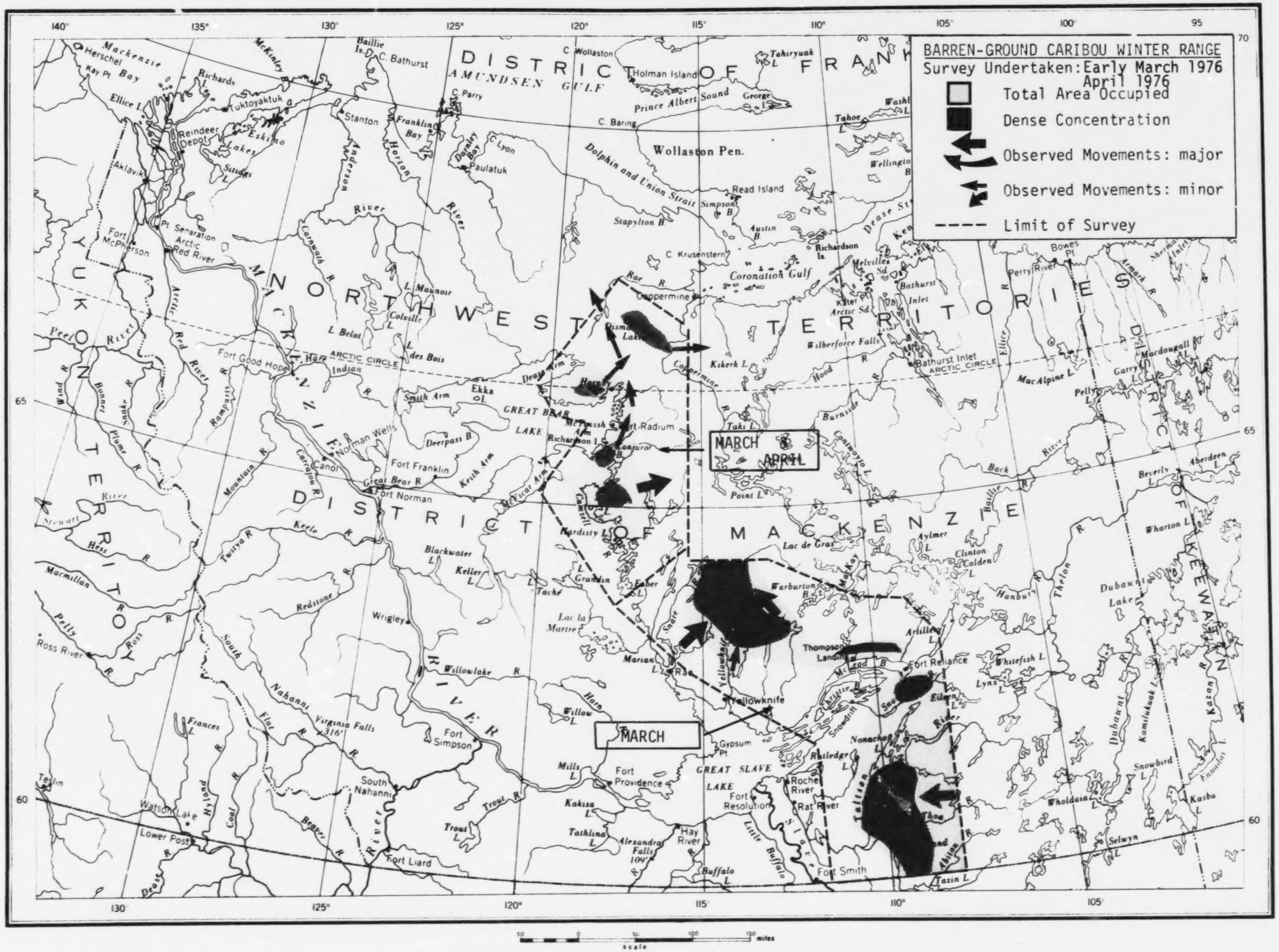

BARREN-GROUND CARIBOU WINTER RANGE
Survey Undertaken: Early March 1976
April 1976
Total Area Occupied
Dense Concentration
Observed Movements: major
Observed Movements: minor
Limit of Survey
MARCH
APRIL
MARCH
DISTRICT OF FRANKLIN
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
YUKON TERRITORY
AMUNDSEN GULF
ARCTIC CIRCLE
GREAT BEAR LAKE
GREAT SLAVE LAKE
Coronation Gulf
Wollaston Pen.
Dolphin and Union Strait
Coppermine
Yellowknife
Fort Smith
Fort Reliance
Fort Simpson
Fort Norman
Fort Providence
Fort Resolution
Norman Wells
Inuvik
Aklavik
Tuktoyaktuk
Port Radium
Lac de Gras
Aylmer L.
Clinton-Colden L.
Artillery L.
Nonacho L.
Thompson Landing
Tazin L.
Mackenzie River
140°
135°
130°
125°
120°
115°
110°
105°
100°
95°
70
65
60
scale
miles
50
0
50
100
150

FIGURE: 13

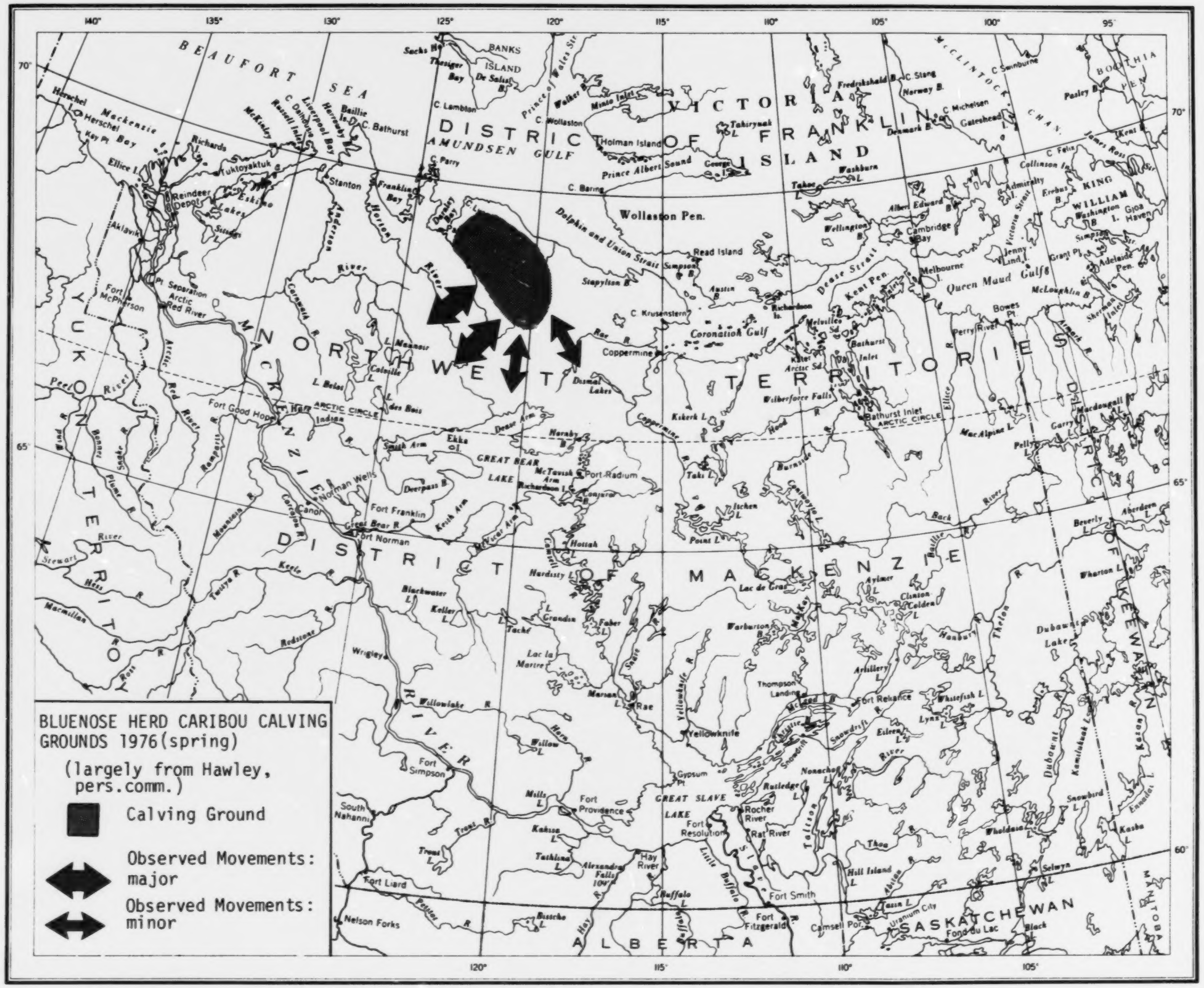
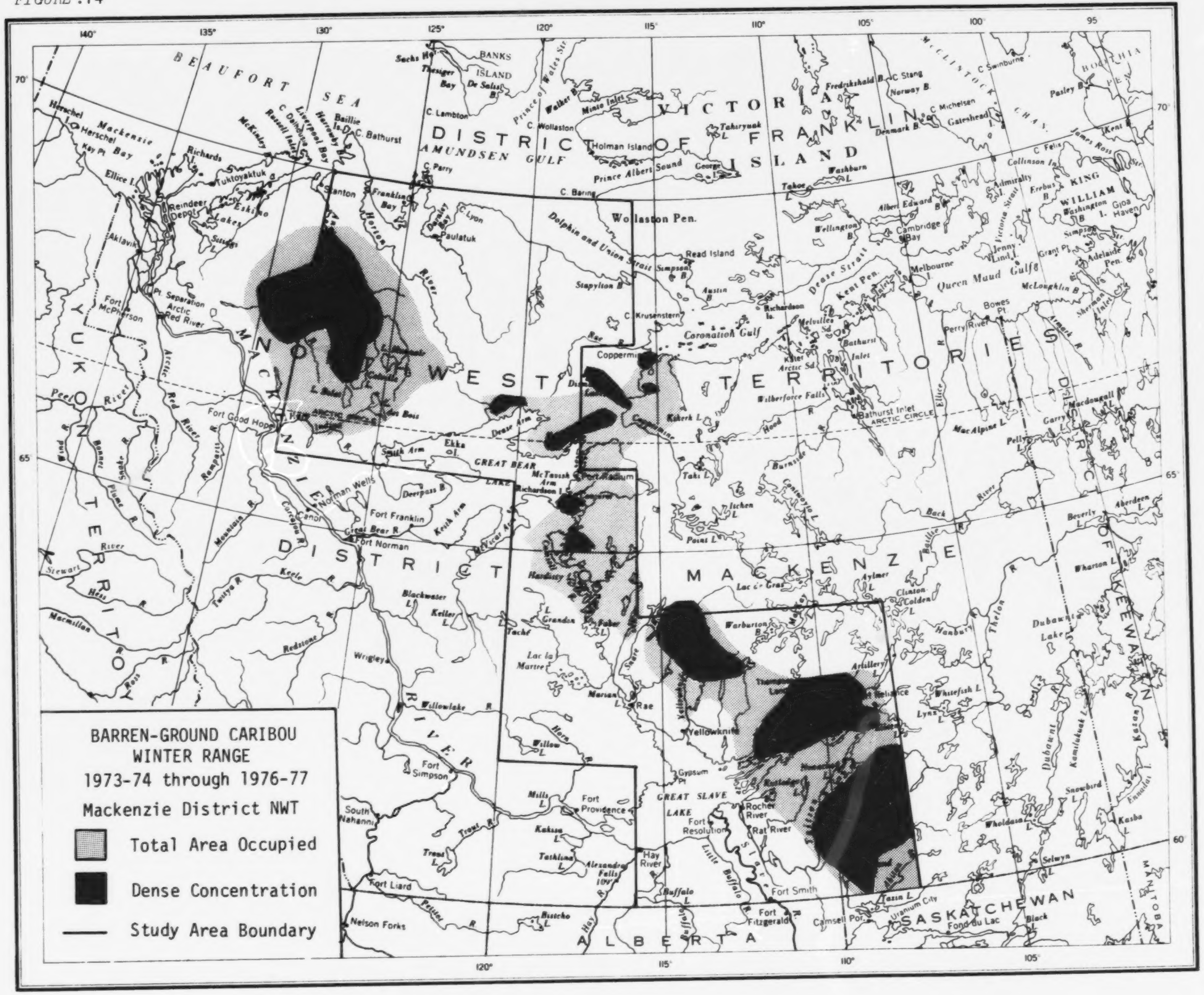

BLUENOSE HERD CARIBOU CALVING GROUNDS 1976(spring)
(largely from Hawley, pers.comm.)
Calving Ground
Observed Movements: major
Observed Movements: minor
BEAUFORT SEA
AMUNDSEN GULF
DISTRICT OF FRANKLIN
VICTORIA ISLAND
BANKS ISLAND
Wollaston Pen.
Dolphin and Union Strait
Coronation Gulf
Queen Maud Gulf
KING WILLIAM I.
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
MACKENZIE RIVER
DISTRICT OF KEEWATIN
YUKON TERRITORY
ARCTIC CIRCLE
GREAT BEAR LAKE
GREAT SLAVE LAKE
ALBERTA
SASKATCHEWAN
MANITOBA
Tuktoyaktuk
Aklavik
Fort McPherson
Fort Good Hope
Norman Wells
Fort Norman
Fort Franklin
Coppermine
Port Radium
Yellowknife
Rae
Fort Simpson
Fort Providence
Hay River
Fort Resolution
Fort Smith
Fort Liard
Nelson Forks
Cambridge Bay
Holman Island
Gjoa Haven
Bathurst Inlet
Uranium City
140°
135°
130°
125°
120°
115°
110°
105°
100°
95°
70°
65°
60°

FIGURE :14



BARREN-GROUND CARIBOU
WINTER RANGE
1973-74 through 1976-77
Mackenzie District NWT
▨ Total Area Occupied
■ Dense Concentration
— Study Area Boundary
BEAUFORT SEA
AMUNDSEN GULF
DISTRICT OF FRANKLIN
VICTORIA ISLAND
BANKS ISLAND
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
YUKON TERRITORY
GREAT BEAR LAKE
GREAT SLAVE LAKE
Coronation Gulf
Queen Maud Gulf
ARCTIC CIRCLE
MACKENZIE RIVER
ALBERTA
SASKATCHEWAN
MANITOBA
Aklavik
Inuvik
Tuktoyaktuk
Fort McPherson
Fort Good Hope
Norman Wells
Fort Norman
Fort Franklin
Paulatuk
Coppermine
Port Radium
Yellowknife
Rae
Fort Simpson
Fort Providence
Hay River
Fort Resolution
Fort Smith
Fort Liard
Nelson Forks
Wrigley
Uranium City
Fort Fitzgerald
Cambridge Bay
Bathurst Inlet
140°
135°
130°
125°
120°
115°
110°
105°
100°
95°
70°
65°
60°

4.3.1 Methods

Specific methods used to determine woodland caribou habitat and movements were very similar to those used for barren-ground caribou. Following are descriptions of the various survey techniques:

a) Literature Review and Field Interviews

South of Great Slave Lake, excluding Wood Buffalo National Park east to the Slave River plain and delta, several pertinent NWT Game Management Division (Wildife Service) surveys are available. Virtually no other area specific woodland caribou information was available.

Woodland caribou calving areas appeared as a distinct spectral signature on LANDSAT imagery. Calving area boundaries were based on these signatures. Two very informative woodland caribou natural history and winter range discussions are by Cringan (1957) and Bergerud (1974).

b) Winter Surveys

Specific surveys were flown, looking for woodland caribou, during mid-March 1974, early March 1975, and mid-November 1975. These surveys were flown, at standard 180 - 240 m AGL and at transect widths of from 32 to 8 kilometres. These were flown between Lac la Martre and the Horn Plateau, and from Great Slave Lake west to the Cartridge Plateau. Additional woodland caribou sightings were noted on various barren-ground caribou reconnaissance surveys.

c) Late-Spring through Early-Fall Surveys

These surveys were in conjunction with wood bison surveys in the Mackenzie Bison Sanctuary. Surveys were flown during April, July, and September 1974 and during March and July 1975.

d) Late-Fall Surveys

Mid-September surveys were flown in 1974 in an attempt to determine migration patterns, if any, for these woodland caribou.

4.3.2 Observations and Discussion

In the bog and forest zone, woodland caribou seem to be widespread. They appear to have specific movements to and from calving and winter areas in the survey area, between Lac la Martre and the Horn Plateau, and between the Cartridge Plateau and Great Slave Lake.

Woodland caribou appear to winter throughout this wildlife zone, but there is a concentration of animals in two areas during winter. In early-winter, to mid-winter, many caribou use the mossy forest zone on the Horn Plateau for winter range. During late winter the snow seems to get very deep on the plateau, probably due to orographic uplift from the prevailing north wind, and the caribou appear to move southward, off the plateau, into the snow shadow.

Woodland caribou calve in the many prairies (drained lakes) in the Mackenzie Bison Sanctuary and in the Birch Lake vicinity (Fig. 15). These caribou can be found with a cow and her calf separate from other caribou, a few on each prairie.

During fall, bulls were observed on these calving prairies. Several long lines of caribou were observed moving west, towards the Horn Plateau in mid-September, in observations over a several-year period. Woodland caribou have much more cryptic coloration on their overall range than barren-ground caribou. Their more solitary habits also make them less easily observable by aircraft. Tracks can be mistaken for moose, bison, or barren-ground caribou. Woodland caribou also show virtually no reaction to aircraft.

4.4. Bison

Bison in the study area were in three major concentrations. The plains-wood bison in Wood Buffalo National Park were excluded from the study. Plains-wood bison in the Slave River plain, generally in the Hook Lake vicinity, and wood bison in the Mackenzie Bison Sanctuary were surveyed.

4.4.1 Methods

Specific methods used to determine bison habitat utilization and presence varied by season. Following are descriptions of the various survey techniques.

a) Literature Review and Field Interviews

Much of the information about the plains-wood bison in the Hook Lake area was obtained from the then ongoing surveys by the NWT Game Management Service (WS). This information was virtually complete and generally covered these bison in excess of reconnaissance survey needs. Some Game Management Service (WS) reports were available on the wood bison of the Mackenzie Bison Sanctuary. These provided a very good start for a survey program. Studies by Van Camp (1975) provided very informative observations of winter bison habits.

Wood bison calving areas and winter range were indicated by a specific spectral signature on LANDSAT imagery. Potential boundaries for the expanding Sanctuary herd were mapped using this signature.

b) Winter Surveys

Field surveys were begun in mid-March 1974 in the two bison survey areas. Additional surveys were flown in the Sanctuary during March 1975, October 1975, and February 1976.

c) Late-Spring through Early-Fall Survey

The Bison Sanctuary and adjacent areas were surveyed periodically throughout the 1974 summer, by air. The Hook Lake vicinity was also surveyed during summer, in conjunction with a Game Management Officer.

4.4.2 Observations and Discussion

Virtually all information concerning the plains-wood bison on the Slave River Plain was published in the LUIS Maps. Data derived from the many wood bison surveys in the Mackenzie Bison Sanctuary are detailed below. Winter range was determined to be consistent year after year. The wood bison use the large prairie of the Falaise, Dieppe, and Calais lakes vicinities for winter range. Cows and calves form large herds on these prairies during winter. Bulls remain solitary, or in pairs, on the fringes of the prairies or in the adjoining smaller meadows.

Summer range in the Sanctuary is more dispersed than during winter but bison still could be found in the vicinity of the winter range. The adults were generally in small groups, both on the large and small meadows, and in the forest. No evidence of bison was found outside the winter range, although several likely-looking meadows were extensively ground-checked.

Wood bison calving areas are also on the large prairies. The only young calves seen were on Falaise, Dieppe, and Calaise lakes, with herds of mixed adults and young on each of the sedge prairies. Fig. 16 illustrates wood bison habitat use in the Mackenzie Bison Sanctuary. Fig. 17 illustrates plains-wood bison habitat use in the Hook Lake vicinity.

Herds and solitary bison invariably ran from survey aircraft. Their distinctive colouring and droppings are readily distinguishable. Surveys tend to disclose bison range readily but range-wide searching is still necessary. Bison can move many kilometres through forests. These movements are even hard to spot during winter, hence the necessity for complete wildlife zone surveys.

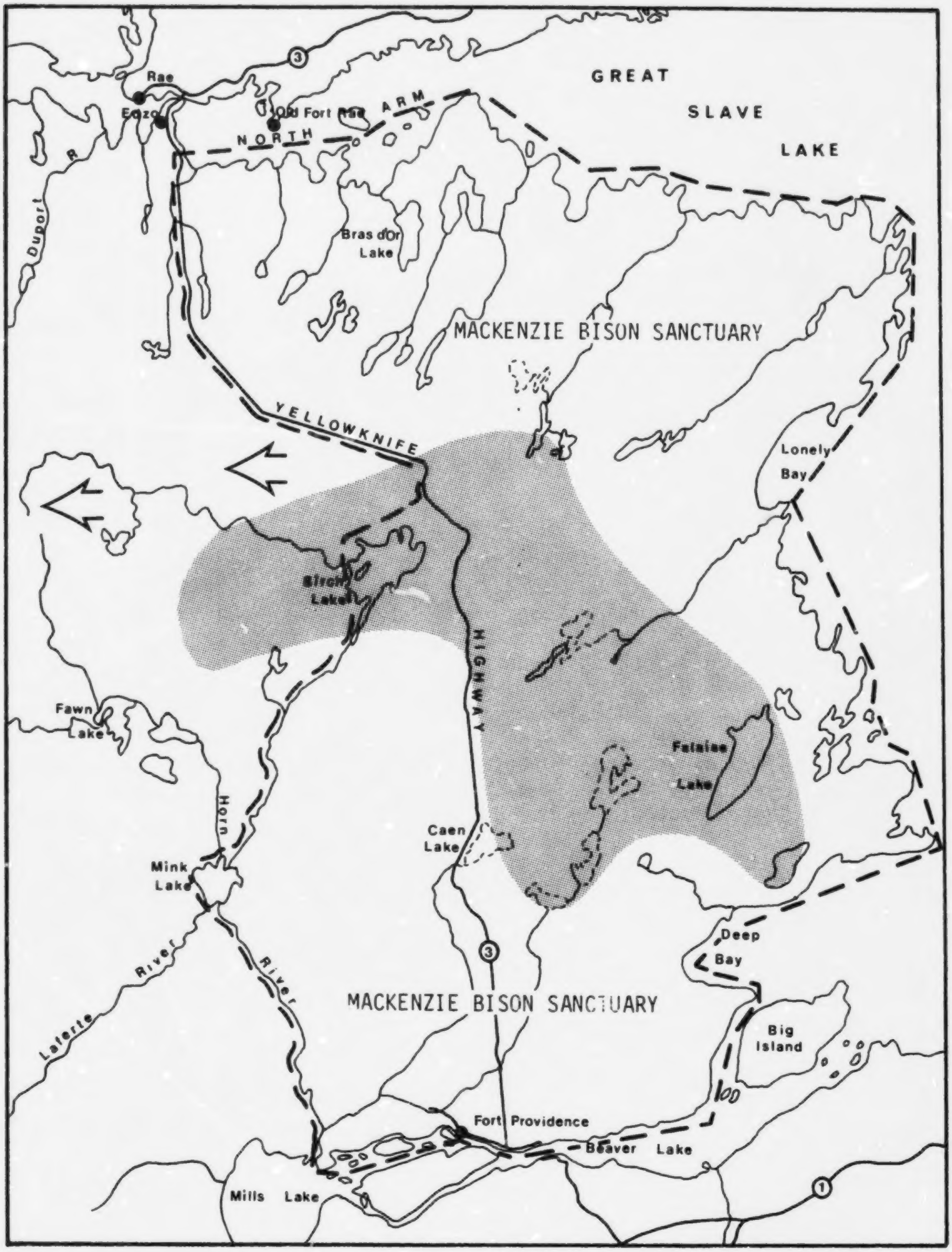
4.5 Muskox

Muskox were known to be on the tundra north of Great Bear Lake and northeast of Great Slave Lake. Numbers and important or critical habitat were essentially unknown.

4.5.1 Methods

Specific methods used to determine muskox habitat utilization and presence varied by season. Following are descriptions of the various survey techniques.

FIGURE: 15 Woodland caribou calving areas

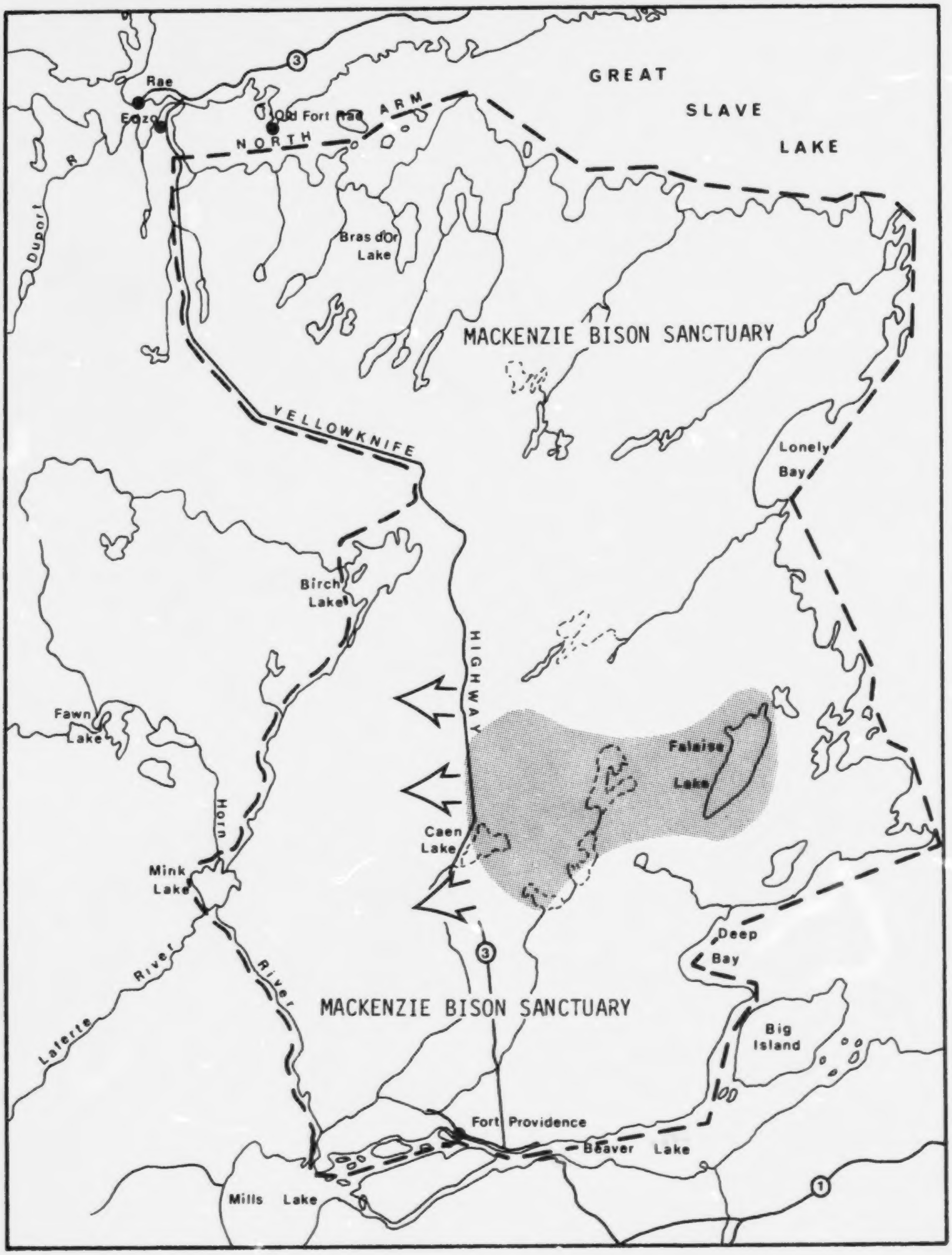


3
Rae
Edzo
Old Fort Rae
NORTH ARM
GREAT SLAVE LAKE
Dupont R
Bras d'Or Lake
MACKENZIE BISON SANCTUARY
YELLOWKNIFE HIGHWAY
Lonely Bay
Birch Lake
Fawn Lake
Falaise Lake
Caen Lake
Horn River
Mink Lake
Deep Bay
Laferte River
MACKENZIE BISON SANCTUARY
Big Island
Fort Providence
Beaver Lake
Mills Lake
1

▨ Area Being Utilized by Woodland Caribou for Calving

⇐ Observed Fall Movements

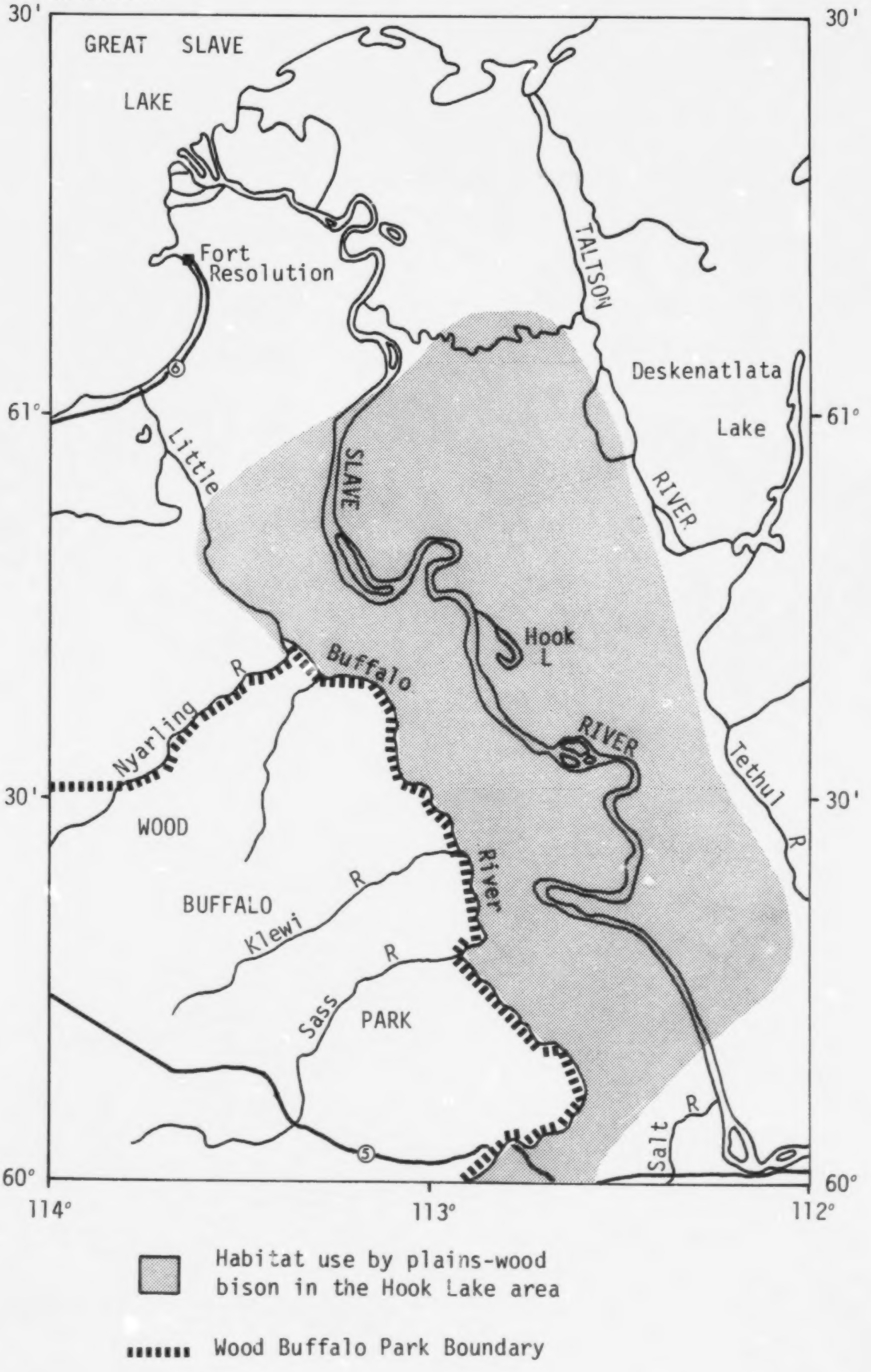
FIGURE: 16 Wood bison range west of Great Slave Lake


Rae
Edzo
Old Fort Rae
NORTH ARM
3
GREAT SLAVE LAKE
Dupont R
Bras d'Or Lake
MACKENZIE BISON SANCTUARY
YELLOWKNIFE HIGHWAY
Lonely Bay
Birch Lake
Fawn Lake
Horn River
Falaise Lake
Caen Lake
Mink Lake
Deep Bay
Lafertе River
MACKENZIE BISON SANCTUARY
Big Island
Fort Providence
Beaver Lake
Mills Lake
1

■ Area Currently Being Utilized by Bison

⇦ Observed Summer Movements

FIGURE:17


30'
30'
GREAT SLAVE
LAKE
Fort Resolution
TALTSON
Deskenatlata
Lake
61°
61°
Little
SLAVE
RIVER
Hook L
Buffalo
R
Nyarling
RIVER
Tethul
R
30'
30'
WOOD
River
BUFFALO
Klewi
R
R
Sass
PARK
Salt
R
5
60°
60°
114°
113°
112°
Habitat use by plains-wood bison in the Hook Lake area
Wood Buffalo Park Boundary

a) Literature Review and Field Interviews

Surveys done by Kelsall, Hawley, and Thomas (1971) north of Great Bear Lake and by Kelsall, Kuyt, and Zoltai (1971) northeast of Great Slave Lake showed presence of muskox. Several NWT Game Management Service (WS) reports also showed muskox range. Work by Tener (1965) was also very informative.

b) Winter survey

Most of the tundra north of Great Bear Lake was surveyed by Hawley (Pers. Commun.) during late winter. These surveys were augmented by winter surveys searching for barren-ground caribou on tundra winter range.

c) Summer Surveys

Reconnaissance surveys throughout the study area produced many muskox sightings on summer range.

4.5.2 Observations and Discussion

Muskox herds were found in greater abundance in several areas north of Great Bear Lake than was known or expected. Information about the muskox herds found was portrayed on the LUIS maps.

The muskox were found in both the sparsely-vegetated tundra, and in the forest-tundra transition. Major muskox areas are the tundra southwest, south, and southeast of Paulatuk, the Bloody and Haldane River watersheds, and the Rae and Richardson River watersheds. A map of muskox distribution can be found in Fig. 18.

Herds of muskox invariably run from the survey aircraft, similar to bison. They can be spotted from great distances both in summer and winter with their black color and blocky shape. Surveys tend to pick up muskox readily. They appear to have large seasonal movements, often of a hundred miles, between summer and winter range. Entire tundra (and forest-tundra) surveys are necessary to find complete muskox distribution.

4.6 Bears

Three species of bears were found, in various habitats, in the study area: black, grizzly, and polar. Polar bears were not studied at all, nor surveyed for, since the massive amount of information available by Stirling *et al.* (1974) far exceeded the reconnaissance level of this project.

Black and grizzly bears were observed on numerous reconnaissance flights. Dens were occasionally found and noted. Tracks and droppings were especially useful for determining bear range and habits.

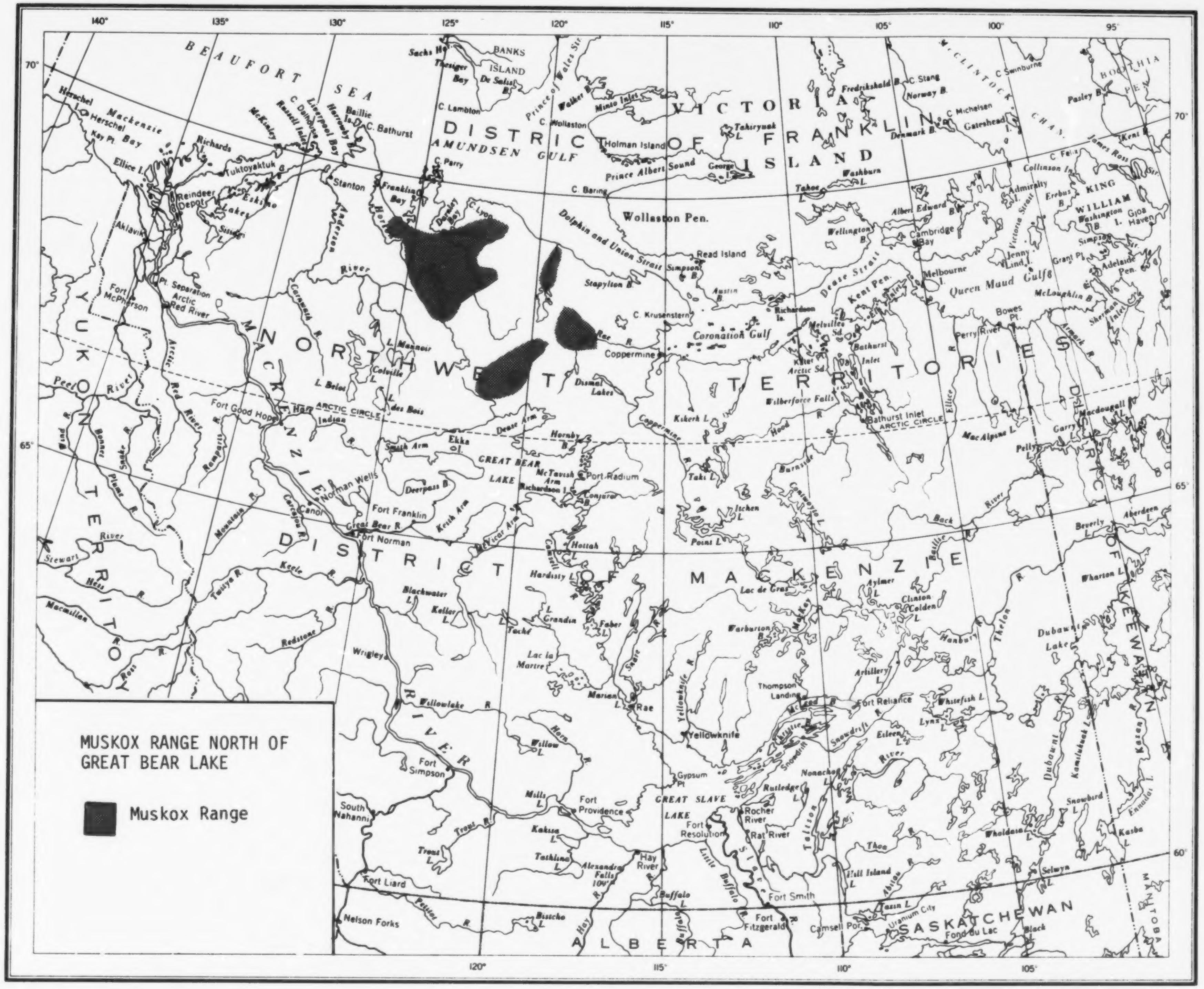
4.6.1. Methods

Specific methods used to determine bear habitat utilization and presence varied by season. Following are descriptions of the various survey techniques.

a) Literature Review and Field Interviews

Very little information about black or grizzly bears was available in the literature. Only scattered observations were

FIGURE:18


MUSKOX RANGE NORTH OF GREAT BEAR LAKE
▇ Muskox Range
BEAUFORT SEA
AMUNDSEN GULF
VICTORIA ISLAND
DISTRICT OF FRANKLIN
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
YUKON TERRITORY
MACKENZIE RIVER
GREAT BEAR LAKE
GREAT SLAVE LAKE
ALBERTA
SASKATCHEWAN
MANITOBA
ARCTIC CIRCLE
Coronation Gulf
Queen Maud Gulf
Wollaston Pen.
Coppermine
Yellowknife
Fort Norman
Norman Wells
Fort Good Hope
Aklavik
Tuktoyaktuk
Fort Simpson
Fort Smith
Fort Resolution
Hay River
Port Radium
140°
135°
130°
125°
120°
115°
110°
105°
100°
95°
70°
65°
60°

available from several interviews. Works by Hatler (1972) and Jonkel and Cowan (1971) on black bears, and Harrington, Macpherson and Kelsall (1962), and Banfield (1958) on grizzly bears were very informative.

Black and grizzly bears have tracks that often look alike. Similarly, they feed along the ecotone of their preferred habitats. But from the air they are more distinguishable. Grizzly bears run rapidly away from aircraft and boats, thus are easily seen. Black bears, however, are less likely to be seen since often they do not move even after several airplane passes.

b) Late Spring through Early Fall Surveys

Reconnaissance surveys, through all wildlife zones, identified many black and grizzly bears, in their respective habitats. River valley surveys resulted in many den and feeding habitat observations.

c) Early Spring Surveys

Surveys in conjunction with barren-ground caribou migration and wolf denning surveys, during early spring, yielded several pertinent bear observations. These were essentially river valley surveys.

4.6.2 Observations and Discussion

Black bears use virtually all of the forest wildlife zones and grizzly bears can be found throughout the tundra. Following are descriptions of wildlife zone use by bears.

a) Bog and Forest Zone

There appears to be more black bears in this wildlife zone than in any other part of the study area. They can be seen during all non-winter parts of the year, feeding in the bogs and forests and moving or resting throughout the area. A number of dens were seen at random locations in the forested portions.

b) Mossy Forest Zone

Black and grizzly bears can be found in this wildlife zone. Grizzly bears are especially common in this zone north of Great Bear Lake. A large number of black bears can be found throughout the Slave River plain and delta portions of this wildlife zone.

c) Glacial Lake McConnell Zone

Relatively few black bears were seen in this wildlife zone, although they can be found throughout the area. One black bear was seen during mid-January, when returning from a barren-ground caribou survey. The bear was eating vegetation in a bog area at -40^{0}C.

d) Open Forest Zone

Black bears can be found throughout this wildlife zone. They appear to have a random distribution with only one noticeable concentration. The many rivers of the Canadian Shield can be classified into two, roughly-equal, numbered types. About half of the rivers are blue-water, fast flowing cold streams, with many rapids. The others occupy the valleys of former glacial rivers. These are black-water rivers, with very sandy valleys. Eskers, sand plateaus, and kettles all are in abundance. These rivers are warmer and slower-moving than the blue-water, or "Arctic grayling" rivers. These black rivers have a lot of lush, summer aquatic vegetation in the shallows during the spring, and black bears congregate along these rivers to feed. Grizzly bears penetrate far into the shield open forest during summer.

e) Forest-Tundra Transition Zone

Both black and grizzly bears can be found throughout this wildlife zone when not in hibernation. Black bears appear to move into this area during summer, whereas grizzly bears den throughout

A unique and widespread feature of this wildlife zone is the massive amount of muskeg overturned by both bear species during the spring. Apparently roots are being searched for.

f) Sparsely Vegetated Tundra Zone

Grizzly bears are found throughout this wildlife zone. Dens can be found in the sandy Hornaday and Horton River valleys.

g) Lush Vegetation Tundra Zone

Grizzly bears especially are found along the sandy esker systems of this wildlife zone, preying on the very numerous ground squirrels, which den in the eskers.

4.7 Forest Furbearers

The forest furbearers included in the study were red fox, marten, lynx and wolverine. While all nominally favor a forest ecosystem, their actual habitat use was far-ranging.

4.7.1 Methods

Specific methods used to determine habitat utilization of red fox, marten, lynx, and wolverine varied by season. Following are descriptions of the various survey techniques.

a) Literature Review and Field Interviews

Very little specific information was available concerning forest furbearers in the study area. NWT Wildlife Service fur catch returns yielded some general distribution information. Sargeant, Pfeifer, and Allan (1975) and Sargeant (1972) were very helpful papers about red fox habitat and natural history. Research

d) Open Forest Zone

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Specific methods used to determine habitat utilization of red fox, marten, lynx, and wolverine varied by season. Following are descriptions of the various survey techniques.

a) Literature Review and Field Interviews

Very little specific information was available concerning forest furbearers in the study area. NWT Wildlife Service fur catch returns yielded some general distribution information. Sargeant, Pfeifer, and Allan (1975) and Sargeant (1972) were very helpful papers about red fox habitat and natural history. Research by Weekwerth and Hawley (1962), and Newby, (1957), were very informative on marten food habits. Nellis, Wetmore, and Kewith (1972), and Van Zyll de Jong (1966) provided valuable insights into food habits and prey relationships of lynx. Rawsch and Pearson (1972) discussed the life history of wolverines in Alaska and the Yukon Territory. Myhre and Myrberget (1975) discuss wolverine diet.

b) Winter Surveys

In conjunction with surveys for barren-ground and woodland caribou, moose, and bison, virtually all forest ecosystems were covered. All tracks, droppings and sightings were plotted.

Abundance of these species is determined virtually only by observations of sign and tracks from numerous ground checks. Presence only can be determined during summer but winter ground surveys over entire wildlife zones can disclose relative abundance in certain areas or of species.

c) Late Spring through Early Fall Surveys

As part of the general reconnaissance surveys, furbearers and sign were searched for and noted.

4.7.2 Observations and Discussion

Forest furbearers were generally widespread and distributed throughout the forest. Some concentrations were apparent. With few exceptions, only red fox are readily observable from aircraft and only in winter. They tend to stand out in coloration when along willow habitats. Very bright days and fresh snow combinations are too rare in winter to allow any aerial survey pretense for any significant track observations of red fox, marten, lynx, or wolverine.

a) Bog and Forest Zone

Many red fox can be found in this wildlife zone. They especially are concentrated in the many willow stands in winter, feeding on the willow ptarmigan and varying hares. Lynx are also abundant in this wildlife zone, preying on varying hares. Marten and wolverine also can be found there.

b) Mossy Forest Zone

Marten are especially abundant throughout all unburned parts of this wildlife zone. This includes the Horn Plateau as well as areas both north and south of Great Bear Lake. Red fox, lynx, and wolverine can also be found in this wildlife zone. Large numbers of red fox and lynx can be found in the Slave River plain and delta portions of this wildlife zone. Marten and wolverine also are found there.

c) Glacial Lake McConnell Zone

The abundant willow growth in this wildlife zone provides excellent habitat for red fox and lynx. Red foxes and lynx are abundant in this wildlife zone, preying heavily during winter on willow ptarmigan and varying hares, which use the willows for feed, and on muskrats in early spring. Marten and wolverine also are found there.

d) Open Forest Zone

All four forest fur species are found in this wildlife zone, but generally not in great abundance.

e) Forest-Tundra Transition Zone

Red fox are especially common in this wildife zone. During winter they concentrate in the willows of the several stagnant ice topography areas. These areas are located north of Great Bear Lake, in the Horton Lake vicinity, where the foxes prey on willow ptarmigan. Wolverine range through this wildlife zone. Few marten or lynx can be found here.

f) Tundra Wildlife Zones

Red fox and wolverines range on to tundra year-round.

4.8 Aquatic Furbearers

Muskrats, mink, beaver, and others are found throughout the forested portion of the study area. Nominally they use all the forest wildlife zones but actually use different parts of the aquatic portions of these areas.

4.8.1. Methods

Specific methods used to determine aquatic furbearer habitat utilization and presence varied by season. Muskrat and beaver are almost surveyable only by spotting their work. Range-wide surveys are needed for relative abundance. Mink are only assessable by tracks. Otters are assessable by feeding sign in summer and by ground surveys near open water (rapids) during winter. Aquatic furbearing species can be more easily assessed by air than forest ones. Muskrat push-ups can be easily seen just after the first light snowfall and in early spring. The black dirt absorbs the sun's rays and the push-ups stand out. Beaver houses and dams are readily observable by air. Mink and otter are observable only by ground surveys for signs.

a) Literature Review and Field Interviews

Very little has been written about aquatic furbearers in this study area. Interviews yielded some specific information. NWT Wildlife Service fur catch returns were of value in determining distribution. Arctic beaver feeding habits were studied by Aleksiuk (1970) Kirby (1976) and Dennington and Johnson (1974), and these reports provide valuable beaver habitat information. Aurbroock and Allison (1972) offer very informative muskrat natural history and habitat observations. An insight into otter winter food habits was provided by Toweill (1974).

b) Winter Surveys

In conjunction with barren-ground and woodland caribou, moose and bison surveys, virtually all forest ecosystems were covered. Tracks, droppings and sightings were plotted.

c) Late-Spring through Early Fall Surveys

As part of the general reconnaissance surveys, furbearers and sign were searched for and noted.

4.8.2 Observations and Discussion

Aquatic furbearers were generally widespread and distributed throughout the forest. Some areas of large populations were noted.

a) Bog and Forest, and Mossy Forest Wildlife Zones

Muskrats, mink, beavers, and otters are found throughout these wildlife zones, but generally not in great abundance. A large population of beaver can be found along the Horn River. Muskrats, mink, and beavers can be found in the Slave River plain and delta, where they are very abundant.

b) Glacial Lake McConnell Zone

Muskrats, mink, and beavers are very abundant in this wildlife zone. The eutrophic, silt-induced vegetation of this zone provides excellent habitat for these species.

c) Open Forest Zone

Otter are common in this wildlife zone, relying on the winter open water of the many rapids. Muskrat, mink, and beaver can be found throughout this zone.

4.9 Arctic Fox

Arctic fox were assumed to be found throughout the tundra wildlife zones in summer and to move well into the forest in winter, in association with barren-ground caribou and wolves.

4.9.1. Methods

Specific methods used to determine Arctic fox habitat utilization and presence varied by season.

a) Literature Review and Field Interviews

MacPherson's (1969) Arctic fox studies provided valuable insights into how to locate dens. There was virtually no other published information concerning Arctic fox in this study area.

b) Winter Surveys

Winter surveys for barren-ground caribou on winter range provided some sightings of Arctic foxes in forest penetrations. Tracks were hard to define and colour was cryptic snow white.

Trapping returns were very helpful by indicating presence of animals.

c) Summer Surveys

Numerous Arctic fox dens were located during summer reconnaissance surveys. These dens were observed as mounds on the tundra. However, not all the mounds (dens) can be listed as fox dens. Wolves may dig out a fox den and use it for a season. Ground squirrels may also occupy a former fox (or wolf) den. Grizzly bears dig out all three types of dens, but especially ground squirrel dens, making the mound or den look like a freshly - occupied den of a larger animal.

While only ground observation can positively identify most active dens, several survey techniques can help the researcher identify dens by species. Active Arctic fox dens have yellow and purple flowers growing around the den area. Ground squirrel dens have a blueish grass growing around them. This is apparently from the different fertilizing effects of the urine and scats. Wolf dens are bigger, with more fresh dirt.

4.9.2. Observations and Discussion

Arctic foxes seem to have a distinct denning habitat preference. They are wide ranging during winter.

a) Forest-Tundra Transition and Sparsely Vegetated Tundra Zones

Arctic foxes den in these wildlife zones, but are generally not abundant.

b) Lush Vegetation Tundra Zone

Of all areas surveyed, this wildlife zone had the most abundant numbers of Arctic fox dens. The Rae and Richardson, and Bloody and Haldane River watersheds had very many fox dens (Fig. 19).

Arctic foxes have fantastic cryptic coloring during both summer and winter. Also, they have a habit of standing immobile when an aircraft passes overhead, or they enter their dens. Dens are readily observable and generally distinguishable from ground squirrel or wolf dens so that Arctic fox dens are surveyable. Relative range-wide abundance can be thus determined. More detailed studies would require ground surveys.

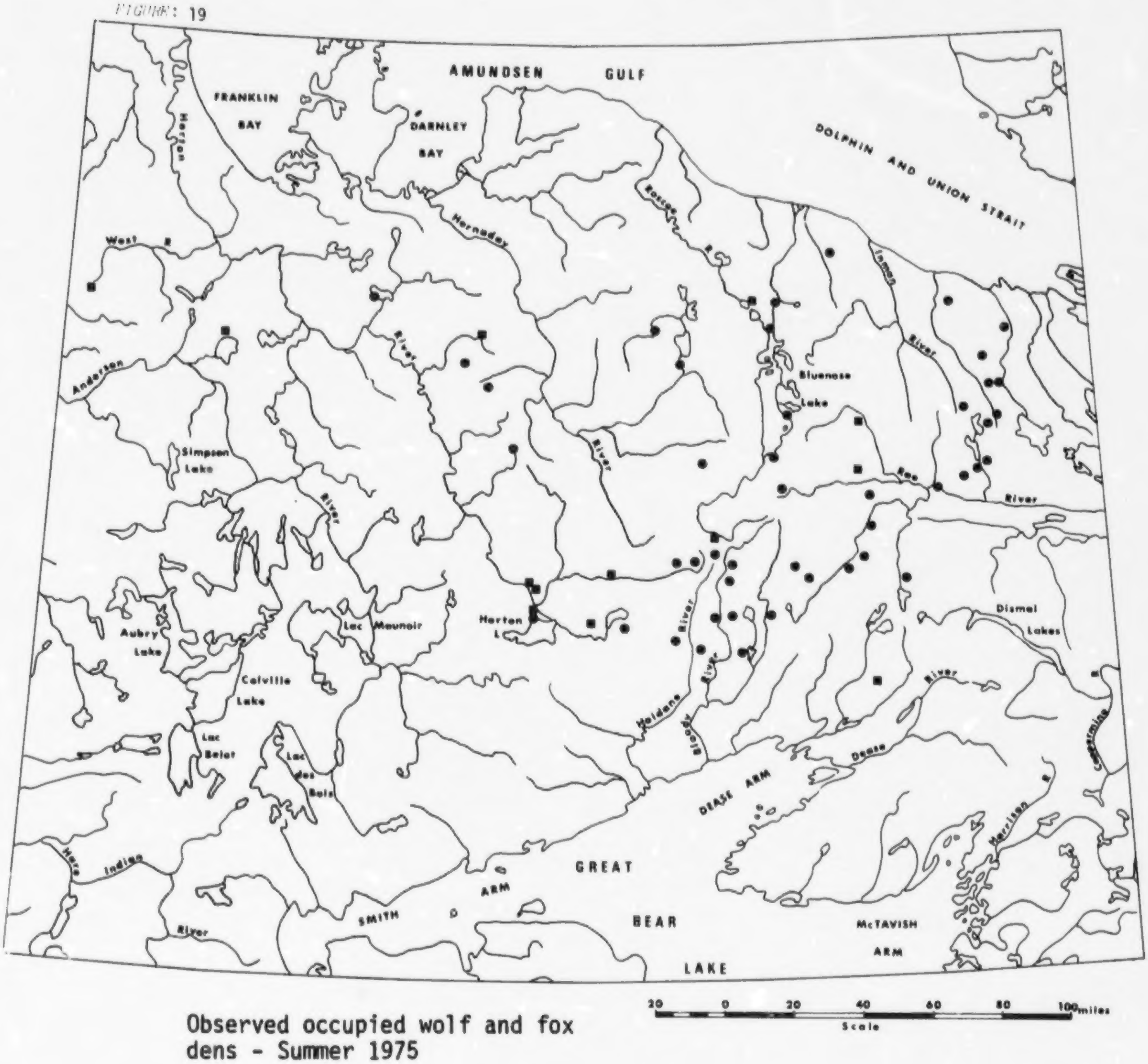
c) Forest Wildlife Zones

Many Arctic foxes move into the forest during winter. They can be found on barren-ground caribou winter range, feeding off wolf kills. They also appear to range southward during winter following migrating willow ptarmigan.

4.10 Wolf

Wolves are found throughout the study area. Forest-dwelling wolves are scattered throughout, while tundra-denning, caribou-following wolves are usually found in more concentrated populations.

FIGURE: 19


AMUNDSEN GULF
FRANKLIN BAY
DARNLEY BAY
DOLPHIN AND UNION STRAIT
Horton
West R.
Hornaday
River
Roscoe R.
Inman River
Anderson
Bluenose Lake
Simpson Lake
River
Rae River
Lac Maunoir
Horton L.
Aubry Lake
Colville Lake
Dismal Lakes
Haldane River
Bloody River
Lac Belot
Lac des Bois
Dease Arm
Dease River
Coppermine
Morrison R.
Hare Indian River
GREAT BEAR LAKE
SMITH ARM
McTAVISH ARM
20 0 20 40 60 80 100 miles
Scale

Observed occupied wolf and fox dens - Summer 1975

- ● Arctic fox den
- ■ Wolf den

4.10.1 Methods

Specific methods used to determine wolf habitat varied by season.

a) Literature Review and Field Interviews

Kuyt's (1972) study of wolves provided much information about wolves in the study area. Theberge and Pimlott (1969) offered valuable insights into wolf forest behavior. Some NWT Game Management Service (WS) survey reports were helpful. They noted the presence of wolves with moose and bison.

It is virtually impossible to survey wolves in the forest during summer. During winter, tracks and actual observations are plentiful. Wolves always run during winter when approached by machine. During summer on the tundra, they remain almost motionless but often can be spotted by shape and color. Dens are readily observable. Wolf tracks in winter and dens in summer are easily surveyed, so that abundance over wide areas can be noted. Detailed surveys would require much ground work.

Wolf dens can be found relatively easily with some practice. Generally, if an esker system (or sand plain - kame) has several wolf dens, it has many. The regime of the esker-forming, under-glacier river appears to determine whether the esker will be good denning habitat. If the under-ice river is flowing rapidly, only the heaviest rocks and gravel will form the river bed. Ground squirrel dens occupy these eskers. If the under-ice river was slower flowing, sand with some mud and silt would form the esker. This is wolf den habitat (Plates 5 and 18).

The holes, tracks, and droppings tell a repeated story. Some clay is needed to keep the den from collapsing. Willows indicate this clay deposit. The willows are able to grow on top of the dry, sandy esker because the clay holds needed moisture. The willow roots also hold the soil together, allowing denning. Kettles are scattered throughout the esker system. These are depressions left from melting ice blocks in the under-ice river bed. The kettles generally have sedge meadows; in them, prime small mammals habitat. The female wolf both feeds on these small mammals during summer and teaches hunting to her young. Many small scats can be found in the kettles, with small bones and hair in them.

b) Winter Surveys

Surveys of barren-ground caribou yielded many wolf observations. In addition, winter surveys of plains-wood and wood bison, and woodland caribou resulted in many wolf observations.

c) Early Spring Surveys

Wolf denning surveys were flown in suspected areas during early spring. Esker areas in the forest-tundra transition wildlife zone were selected and concentrated on.

4.10.2 Observations and Discussions

Wolves were observed throughout the year in all wildlife zones. Specific seasonal concentrations occurred.

a) Bog and Forest Zone

Wolves were generally not in great abundance in this wildlife zone, except in the Slave River Plain. The plains-wood bison and the moose, in this portion of the wildlife zone, have a large predatory wolf population.

b) Sedimentary Plain Mossy Forest

Wolves were abundant in this wildlife zone during winter. They were associated with both barren-ground and woodland caribou.

c) Glacial Lake McConnell Area

There are many wolves in this wildlife zone, associated with the large moose population.

d) Canadian Shield Open Forest

Wolves follow the barren-ground caribou onto this wildlife zone in winter in great numbers, returning towards the tundra with the caribou in late-winter.

e) Forest-Tundra Transition

Wolf dens were found throughout this wildlife zone in very large numbers. Wolves follow the caribou onto the edge of the tundra and stop to den in suitable habitat.

f) Tundra Wildlife Zones

Wolves were found in limited numbers throughout these ecosystems.

4.11 Migratory Waterfowl

Swans, geese, and ducks pass through and nest throughout the study area. Some areas provide better nesting or staging habitat than others, resulting in larger populations. The areas of the Mason and lower Horton rivers and the Perry Peninsula were surveyed extensively by Dr. T. Barry, CWS (Pers. Commun.), and his data for these areas was used for the LUIS maps.

4.11.1 Methods

a) Literature Review and Field Interviews

Very little information was available about migratory waterfowl in the study area, with the notable exception of Dr. Barry's excellent comprehension of the coastal waterfowl populations (Barry, 1974). He also provided very detailed information about staging areas west and south of Great Slave Lake. Information from Nettleship and Smith (1975) was very helpful. All identification was from Robbins, Brown, and Zim (1966).

b) Summer Surveys

With the exception of the coastal areas described above, all of the study area was covered by reconnaissance surveys. All concentrations of swans, geese or ducks were noted, by species and function. Staging, nesting or molting areas were outlined.

c) Spring and Fall Surveys

Large, shallow, eutrophic lakes and river systems were surveyed during spring and fall, to search for staging areas.

4.11.2 Observations and Discussion

Migratory waterfowl were found throughout the study area. Several significant staging, nesting, and molting concentrations were found. Swans are easily spotted by aerial surveys. Nests and young are countable. Geese are also surveyable, but need much more care in identification. Ducks are only classified into puddle or diving varieties. Molting or migratory staging areas are readily spotted by air. Range-wide surveys of swans are useful tools to determine abundance. Relative abundance of geese and ducks also can often be determined by aerial surveys.

a) Bog and Forest Zone

Throughout this wildlife zone, swans, geese and ducks use the many shallow ponds and lakes for feeding and nesting while migrating. Some Canada geese and puddle ducks nest in this zone during summer. The Fawn and Second lakes portion of the Horn river and Little Buffalo Lake, remaining ice-free as bigger lakes, hold very many swans, geese and ducks during fall migration. Large numbers of waterfowl pass through the Slave River plain and delta on spring and fall migrations. Many ducks nest throughout this area, especially the Slave River delta.

b) Open Forest Zone

This wildlife zone, especially north of Great Bear Lake, provides excellent nesting habitat for whistling swans. They are found throughout this wildlife zone but have some nesting concentration areas (Fig. 20).

c) Glacial Lake McConnell Zone

This wildlife zone contains a very important concentration of nesting scaup ducks. Many puddle ducks, including many mallards, nest here. The La Martre and Marian rivers have large concentrations of staging whistling swans during spring and fall migration.

d) Open Forest, Forest-Tundra Transition, and Sparsely-Vegetated Zone.

Few migratory waterfowl were found in these wildlife zones. The Snowdrift River is an exception, and it is used by non-breeding Canada geese for molting.

e) Lush Vegetation Tundra Zone

Many whistling swans and geese nest in this wildlife zone. Whistling swans, in particular, are abundant (Fig. 20). The islands of Dolphin and Union Strait, adjacent to this wildlife zone, are very important as common eider duck nesting sites.

4.12 Raptors

Bald and golden eagles, gyrfalcons and peregrine falcons were surveyed for. They were located on summer surveys.

4.12.1 Methods

Following are specific techniques used to determine eagle and falcon habitat utilization and presence.

a) Literature Review and Field Interviews

Work by Fyfe, Temple and Code (1976) lists much habitat as potentially suitable for falcon habitat. Platt (1976) discusses gyrfalcon natural history in the study area. Virtually, no specific information exists about eagles in this study area. Whitefield *et al.* (1974) discusses bald eagles nesting habitat and Mosher and White (1976) discuss golden eagle nesting habitat requirements.

b) Summer Surveys

Summer reconnaissance surveys were designed to include likely raptor cliff-nesting habitat. Eagle observations were from regular summer flights.

4.12.2 Observations and Discussion

Eagles and falcons appear to have relatively specific ecosystem concentrations. Following are wildlife zone descriptions of these raptors' habitat, where observed.

Bald eagles are easily spotted by air. Golden eagles are almost as easily surveyed. Falcons are only spotted by chance, unless spooked from a cliff nest by too-close flying.

Eagle surveys are an easy part of routine reconnaissance surveys, and abundance can be determined. Falcons cannot be successfully surveyed for, except by very detailed flying in all cliff habitat.

a) Bog and Forest, and Mossy Forest Zones

This generally is not good eagle or falcon habitat. An exception is the Taltson River, downstream, between the Slave River plain and delta and the Glacial Lake McConnell wildlife zone, which has a large bald eagle population.

b) Glacial Lake McConnell Area, Canadian Shield Open Forest, and Forest-Tundra Transition.

Bald eagles nest throughout these wildlife zones (Fig. 21). Nests are generally near rapids, on blue water rivers. Falcon habitat can be virtually anywhere in this wildlife zone. Golden eagles are also found in the forest-tundra wildlife zone.

c) Tundra Wildlife Zones

Golden eagles can be found throughout these wildlife zones (Fig. 20). Falcon habitat can be virtually anywhere their rocky cliff habitat exists.

SPECIAL STUDIES - REACTIONS OF WILDLIFE TO AIRCRAFT

5.1 Introduction

Although the primary function of field reconnaissance flights was to identify critical and important land use by wildlife, these surveys provided the author with a unique opportunity to observe and record the reactions of animals to the survey plane. A tabulation of the reactions was suggested by Dr. G. Calef, NWT Wildlife Service, and a preliminary version of his paper on wildlife reactions was very informative (Calef, De Bock and Lortie, 1976).

5.2 Methods

All surveys were flown using ski or float equipped Cessna 185 aircraft. Transects were usually 20 mi apart and generally at 800ft above ground level (AGL). Some surveys were flown at lower altitudes (100 ft, 200 ft or 500 ft) when searching for some specific features. Lower altitude surveys were generally flown at 100 mph with approximate power settings of 4200 rpm and 20 in. of manifold pressure. Normal (800 ft) surveys were generally flown at 130 mph with 2400 rpm and 24 in. of manifold pressure.

Recorded reactions of animals were those of most individuals in the particular group directly flown over. Only those groups directly flown over were recorded. AGL refers, in all cases, to actual height above the animals. Surveys (flight lines) were always flown straight and level or down the center of river valleys, again at a uniform height. No attempt was ever made to divert to fly over or near groups of animals, nor were groups of animals veered away from. The activity of the animals prior to being flown over was recorded when noted. Table 2 lists the classification used for reactions and prior activity.

5.3 Observations and Discussions

Reactions of wildlife to the survey aircraft were recorded occasionally in 1974. During 1975 and 1976, year-round records were kept of virtually all reactions. Some reactions were recorded during early 1977.

These reaction observations represent systematic recordings by the same surveyor, under very similar flying conditions, year-round, over a three-year period. The same pilot was used for virtually all surveys.

Comparisons with previous work offer some similarities. Calef, De bock, and Lortie (1976) also found resting caribou generally less reactive than feeding ones. Their work differs from this study, however, in two major ways. First, most of their reactions are from less than 500 ft and secondly, they are observations of a specific, mountain-oriented caribou herd. The following study provides reactions of many species throughout the District of Mackenzie, to the most commonly-used local aircraft, at normal altitudes and power settings.

5.3.1 Moose

Over a three year period, 195 responses of moose to the survey aircraft were recorded. Reactions were from winter and summer, and were from single to groups of three moose. Overall, 11% of the moose exhibited an escape response, mostly in deep snow, and 89% exhibited minimal response. (Fig. 22; Plate 11).

5.3.2 Barren-ground Caribou

More than 3,000 barren-ground caribou individual and group reactions to aircraft were recorded year-round during 3 years. The reactions are discussed below. Caribou on winter range were differentiated into reactions observed when resting and when feeding. Summer reactions were not as easily divided. All migration reactions (82) were minimal (3) and were flown at 800 ft.

a) Winter Range: Resting

Slightly more than 1,000 recordings were made of barren-ground caribou reactions to aircraft when they were observed resting on winter range. The criteria for resting were defined as animals on a lake when not migrating (Plate 12); or on tundra hilltops, standing or lying down. The first 1,000 reactions were tabulated and graphed (Fig. 23). Twelve groups showed panic reactions, 180 showed escape reactions and 808 groups showed minimal reactions.

b) Winter Range: Feeding

Feeding caribou were all those observed in the forest, not migrating; or when seen feeding on the tundra (Plate 13). The first 1,000 reactions were tabulated and graphed (Fig. 24). 61 groups showed panic reactions, 273 escape reactions, and 666 groups exhibited minimal response to the survey aircraft. The higher escape and panic reactions are probably due to the caribou being in the forest and not on escape terrain (lakes). The caribou were not as reactive on the tundra while feeding.

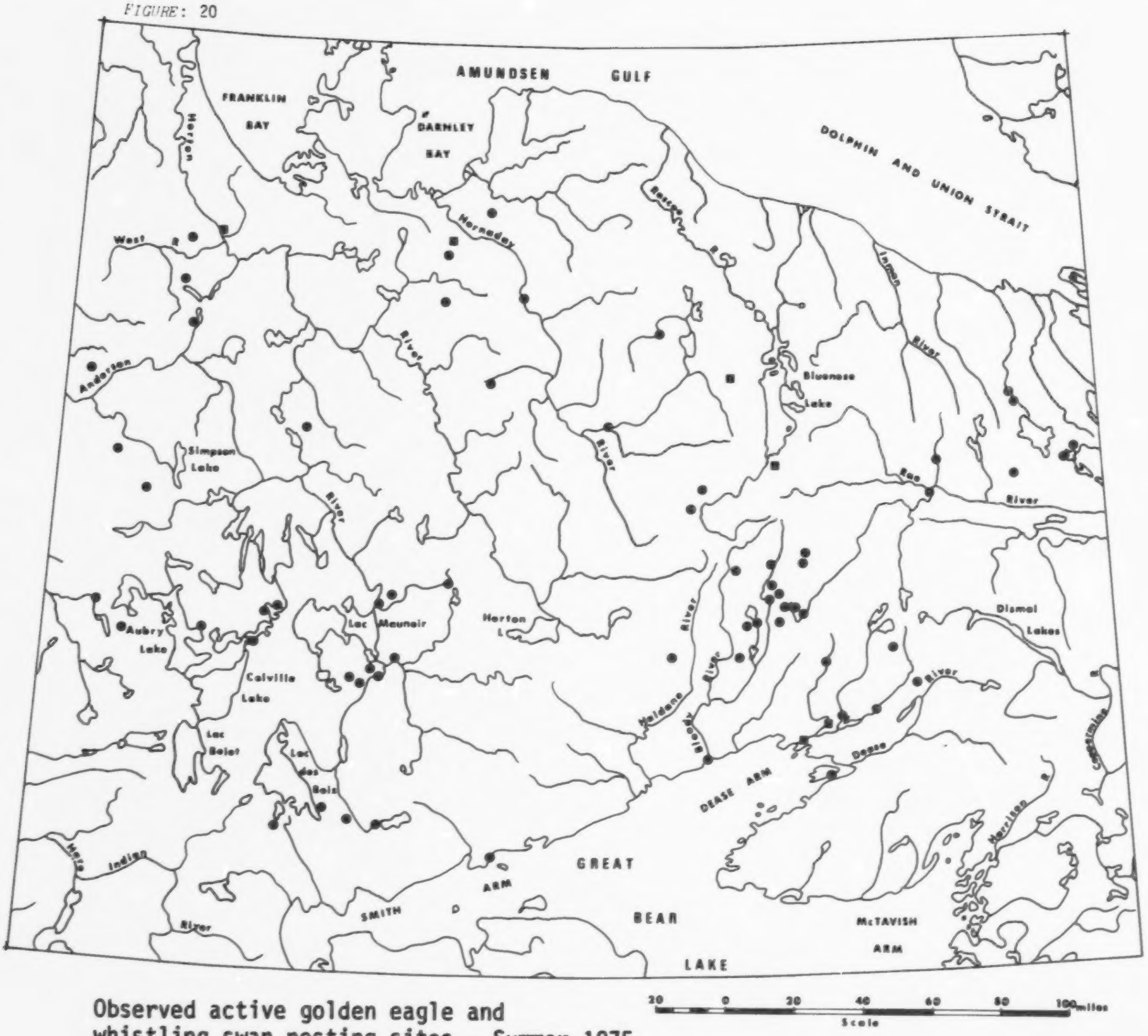
c) Summer Range

1,000 observations were made on summer range (Fig. 25). This included calving and staging animals. 62 groups exhibited panic response, 213 escape, and 725 showed minimal reaction to the survey aircraft. There was no difference in reaction with calves present and no noticeable difference with large groups. There appeared to be more escape responses with large post-calving congregations. Several individual caribou showed panic response in excess of what would be expected from an overflying aircraft. Possible insect harrasment was suspected.

5.3.3 Woodland Caribou

Not enough woodland caribou winter responses were recorded to comment on specifically, but generally, they behave similar to barren-ground caribou on winter range.

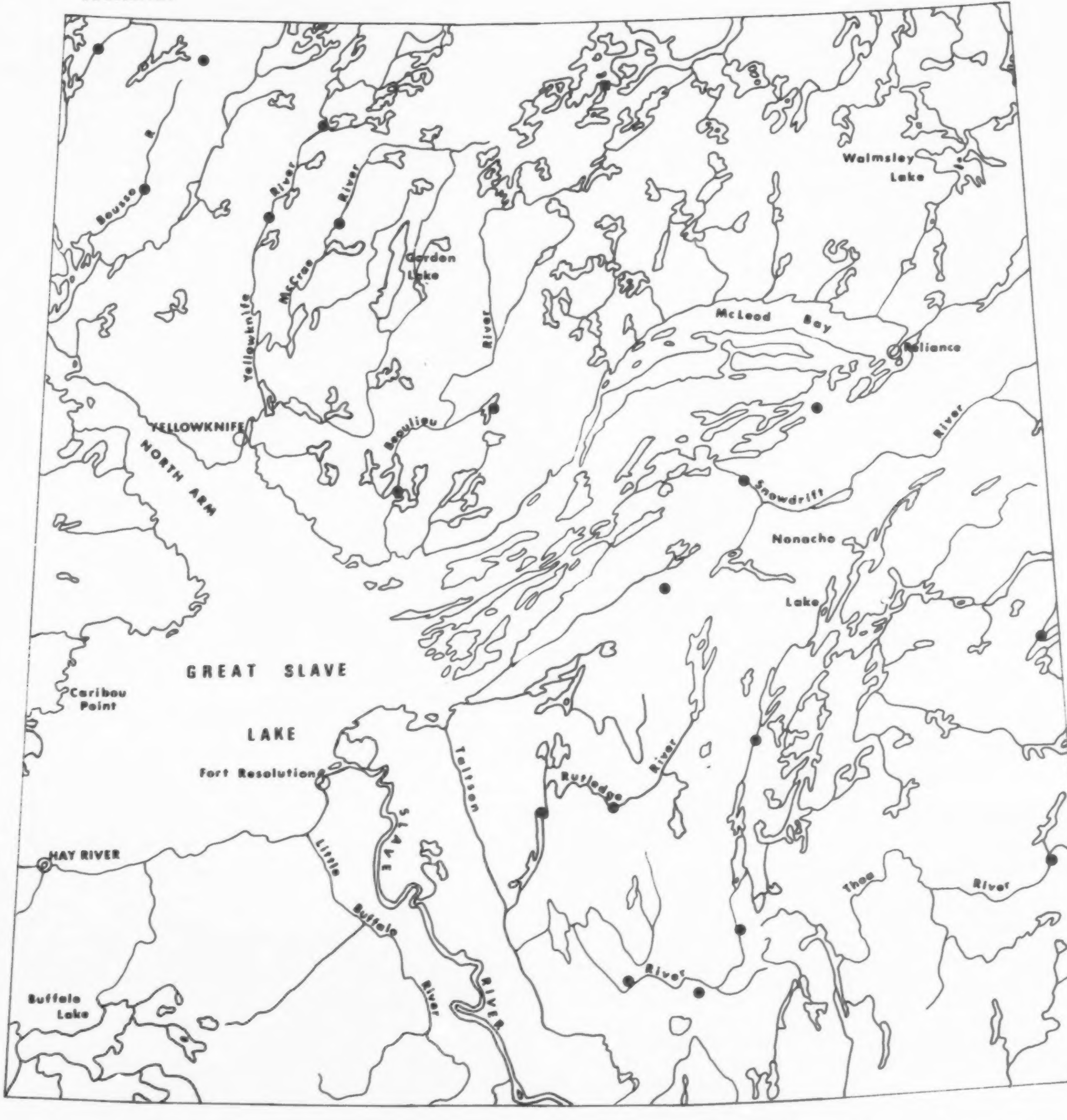
FIGURE: 20


AMUNDSEN GULF
FRANKLIN BAY
DARNLEY BAY
DOLPHIN AND UNION STRAIT
Horton
West R.
Hornaday
Anderson
River
Simpson Lake
Bluenose Lake
Inman
River
Rae
River
Horton L.
Lac Maunoir
Aubry Lake
Colville Lake
Lac Belot
Lac des Bois
Haldane
Bloody
River
Dismal Lakes
Dease
Harrison R.
Coppermine
DEASE ARM
GREAT BEAR LAKE
SMITH ARM
McTAVISH ARM
Hare Indian River
20 0 20 40 60 80 100 miles
Scale

Observed active golden eagle and
whistling swan nesting sites - Summer 1975

- ■ Golden eagle nesting site
- ● Whistling swan nesting site

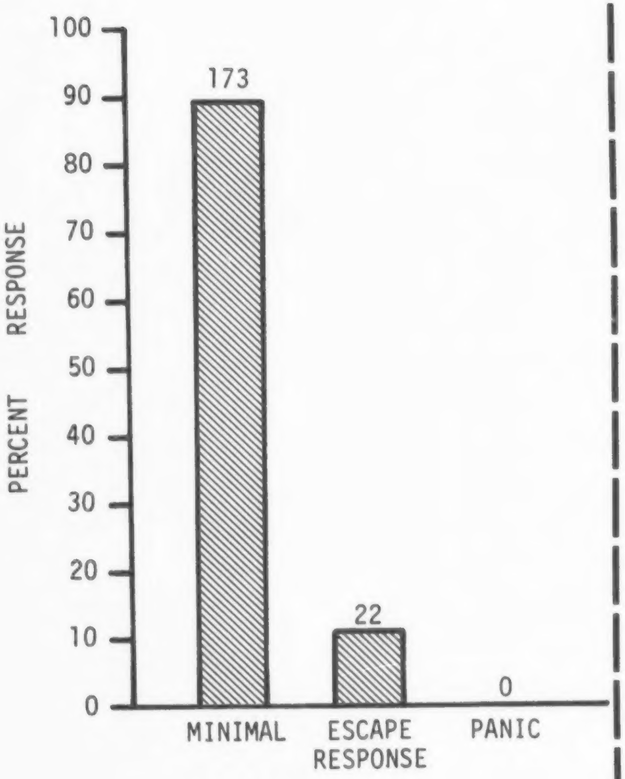
FIGURE:21


Bousso R.
Yellowknife River
McCrae River
Gordon Lake
River
YELLOWKNIFE
NORTH ARM
Beaulieu
McLeod Bay
Reliance
Walmsley Lake
Snowdrift
River
Nonacho Lake
GREAT SLAVE LAKE
Caribou Point
Fort Resolution
HAY RIVER
Little Buffalo River
SLAVE RIVER
Taltson
Rutledge River
Thoa River
River
Buffalo Lake
20 0 20 40 60 80 100 miles
Scale

Observed active golden eagle and bald eagle nesting sites - Summer 1974

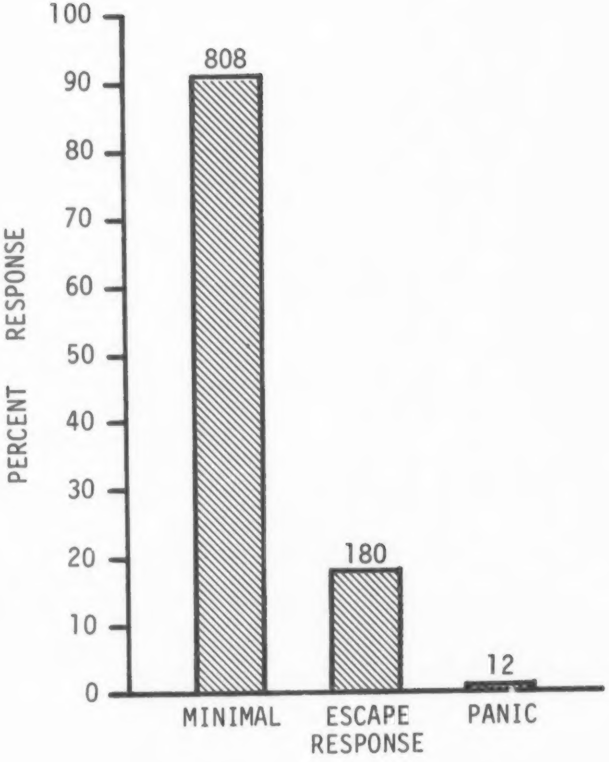
- ■ Golden eagle nesting site
- ● Bald eagle nesting site

FIGURE: 22



MOOSE REACTION TO AIRCRAFT YEAR-ROUND, ALL FUNCTIONS (±800 FT AGL) 195 RESPONSES

FIGURE: 23



BARREN-GROUND CARIBOU REACTION TO AIRCRAFT ON WINTER RANGE WHILE RESTING (±800 FT AGL) 1000 RESPONSES

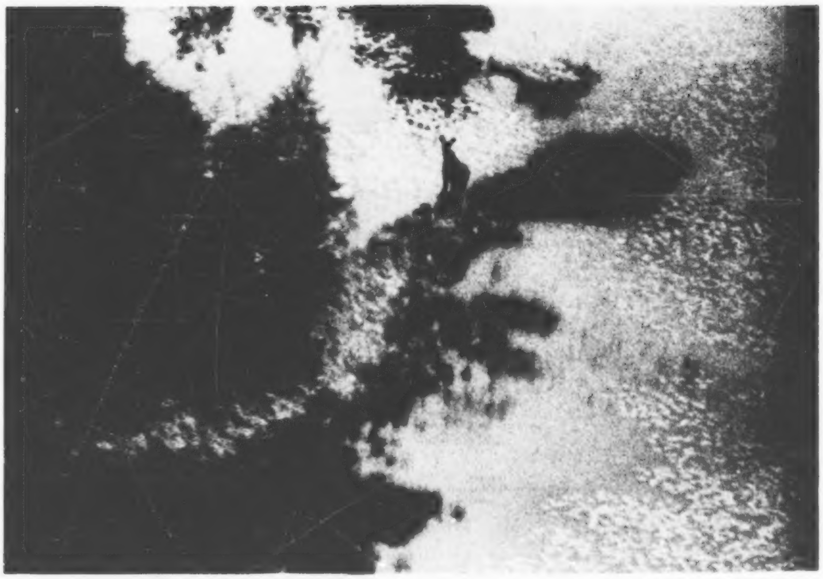


Plate 11 Cow and calf moose exhibiting minimal reaction to overflying aircraft (telephoto). This reaction would be classified 1+1MSrs23 (cow with calf moose on summer range, feeding, with minimal response)

Plate 12 Barren-ground caribou exhibiting minimal response to the survey aircraft on resting habitat, on forest winter range even after a low pass and landing (telephoto)

TABLE 3. Classification of animal reaction to aircraft and prior activity

PRIOR ACTIVITY	CLASSIFICATION
RESTING	1
FEEDING	2

REACTION	CLASSIFICATION
MINIMAL	3
ESCAPE	4
PANIC	5

Resting or feeding were noted if observed. Minimal reactions were such movements as turning to see the aircraft, or merely turning the head. Escape reactions were those with short trots, nervous - appearing jumps, or general movement away from the aircraft. Panic responses were racing flight, or rapid running away from the aircraft.

21 summer range and calving responses were recorded, all reactions were from 800 ft AGL. 13 observations were females with calves (Plate 14). None exhibited more than minimal reaction.

5.3.4 Bison

67 observations of plains-wood, and mostly, wood bison reactions to aircraft were recorded. 9 groups exhibited minimal reaction, 17 escape reaction, and 44 groups exhibited panic reaction to the survey aircraft (Fig. 26).

All of the minimal reactions were groups of two, probably bulls (Plate 15). The escape responses were groups both with and without calves but the panic responses were all groups with calves (Plate 16). Single bison were presumed to be bulls, and generally exhibited minimal reactions to the survey aircraft. In deep snow, some possibly exhibited a slight escape response.

5.3.5 Muskox

100 reactions of muskox to the survey aircraft were recorded. These were all north of Great Bear Lake. These are all summer range and calving observations. Muskox on winter range seemed to exhibit more panic responses than during summer but not enough quantitative information was recorded to produce a graph.

52 groups exhibited panic reaction to the survey aircraft, all with calves. 33 groups showed escape responses (Plate 17), most with calves, and the 15 minimal response groups were all with two individuals, probably bulls (Fig. 27). All single indivudual muskox observed exhibited minimal response.

5.3.6 Bears

26 black bear reactions to the survey aircraft were recorded, mostly during spring, along streams or on ponds. One sighting was in January. All reactions were minimal, including those with cubs. Flights were at 800 ft AGL.

29 observations of grizzly bears were made on summer territory. All were panic or escape responses. All 8 panic observations were with cubs.

5.3.7 Forest Furbearers

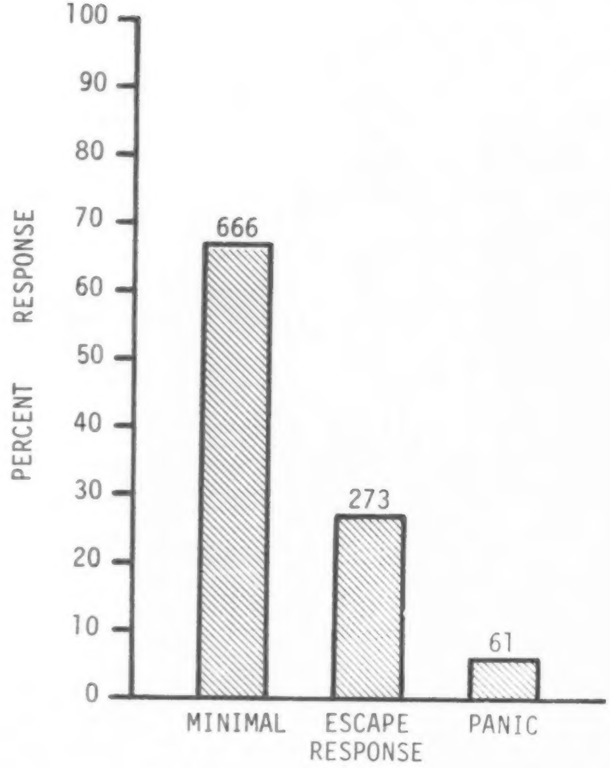
Only red foxes were observed readily, and in enough detail to record reactions to the survey aircraft. Marten, lynx, and wolverines were seldom seen when flying. 42 observations were recorded, and all were minimal reactions. Flights were at 800 ft AGL.

Red foxes were seen in the winter in the vicinity of willows, probably preying on willow ptarmigan and varying hares. In the spring they were seen on lakes, on ice, preying on muskrats.

5.3.8 Aquatic Furbearers

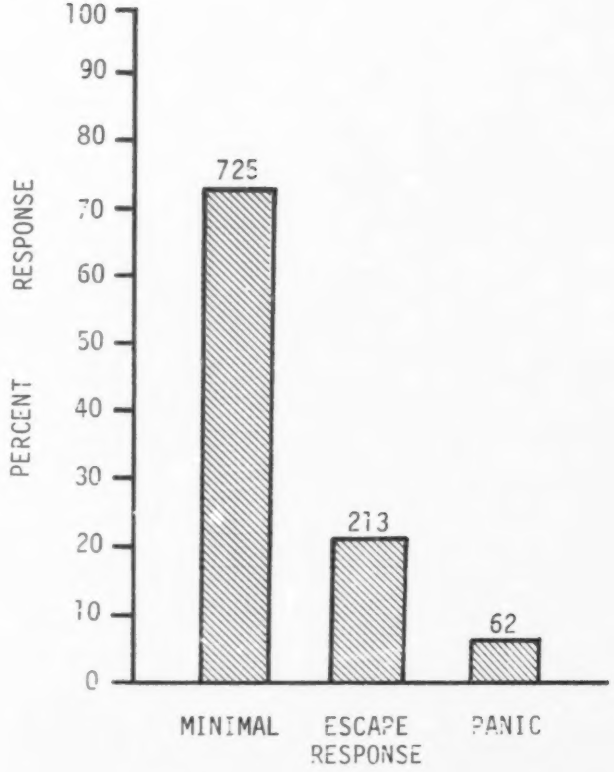
Muskrats, mink, beaver, and otter were seldom seen from the survey aircraft, and certainly not in enough detail for determining reactions.

FIGURE: 24



BARREN-GROUND CARIBOU REACTION TO AIRCRAFT ON WINTER RANGE WHILE FEEDING. (± 800 FT AGL)
1000 RESPONSES

FIGURE: 25

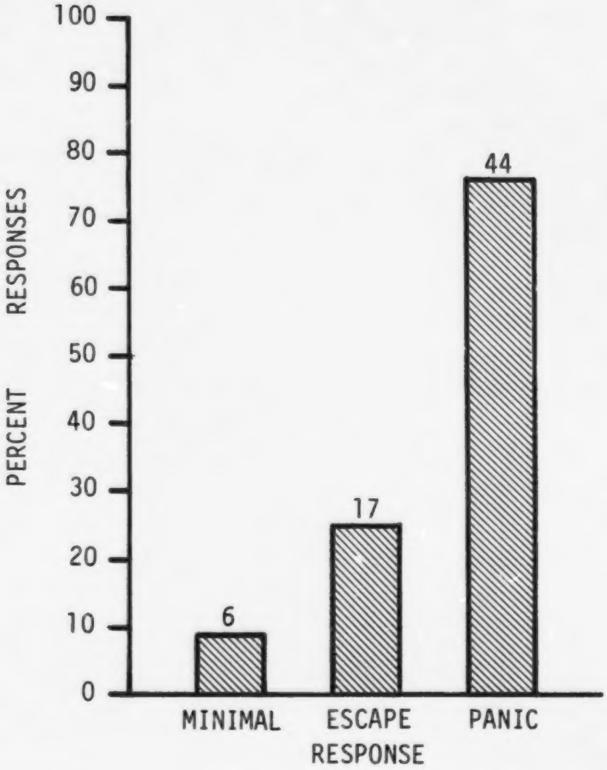


BARREN-GROUND CARIBOU REACTION TO AIRCRAFT ON SUMMER RANGE, ALL FUNCTIONS, (±800 FT AGL) 1000 RESPONSES

Plate 13 Barren-ground caribou exhibiting minimal reaction to survey aircraft feeding on the tundra (± 10 Brw 23)

Plate 14 Woodland caribou showing virtually no reaction to the overflying survey aircraft while feeding on the calving ground (1 + 1 Cns 23; telephoto)

FIGURE: 26

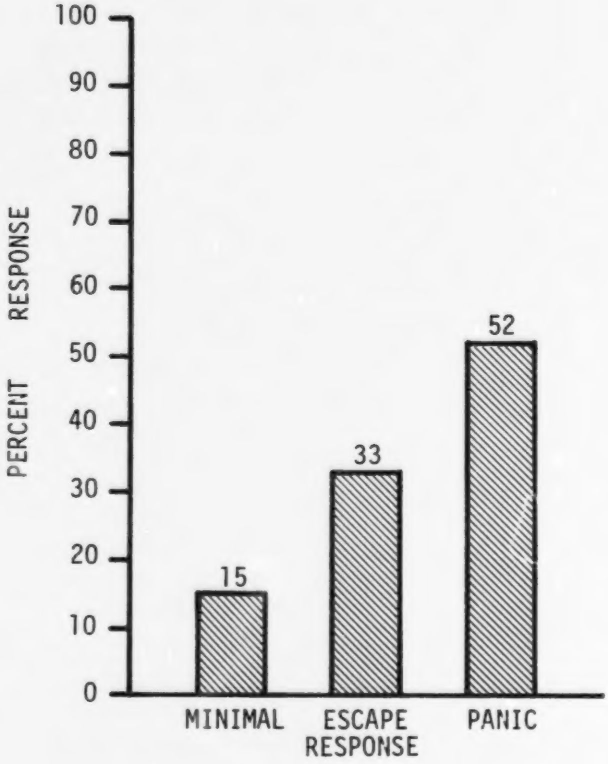


BISON REACTION TO AIRCRAFT, YEAR-ROUND, ALL FUNCTIONS,
≥2 INDIVIDUALS (±800 FT AGL) 67 RESPONSES

Plate 15 Bull wood bison on summer range (salt covered dried lake bottom) showing no response to survey aircraft (21 BN rs 23)

Plate 16 Wood bison on winter range exhibiting panic response, prior to overflight by the survey aircraft (± 35 BN rw 5; No feeding or resting prior activity noted).

FIGURE: 27



MUSKOX REACTION TO AIRCRAFT ON SUMMER RANGE, ALL FUNCTIONS, ≥ 2 INDIVIDUALS (±800 FT AGL) 100 RESPONSES

5.3.9 Arctic Fox

The cryptic coloration and shy or immobile habits of Arctic foxes resulted in very few observations from survey aircraft.

5.3.10 Wolf

32 responses of wolves on winter territory were recorded. Groups of wolves varied from 4 to 12 individuals. Observations were on barren-ground caribou winter range except one on woodland caribou winter range and one on bison winter range. 24 groups exhibited panic reaction and 8 groups escape response to the survey aircraft (Fig. 28). The escape response appeared to occur in less deep snow than the panic response.

8 responses to survey aircraft were recorded from den sites. 6 minimal reactions were from individuals, lying on eskers near dens (Plate 18). 2 escape reactions were from wolves with small cubs.

5.3.11 Migratory Waterfowl

Geese and ducks were noted in their habitat. Low identification flights were usually made. Geese and ducks usually reacted in what would be classified as an escape response, but reactions varied from what could be interpreted as panic to minimal reaction. No quantitative notes were made.

Whistling swans were observed in the vicinity of nesting areas. 100 reactions were recorded, and all were minimal. Flights were 500 to 800 ft AGL.

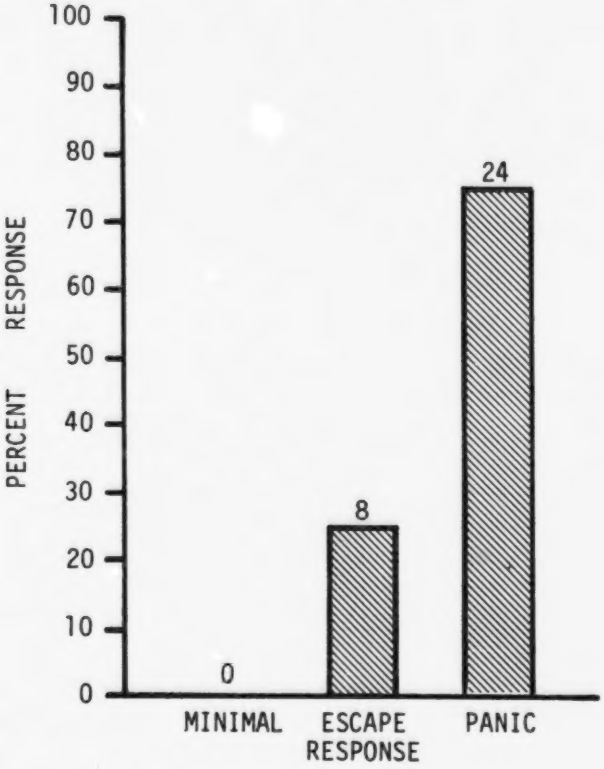
5.3.12 Raptors

Bald and golden eagles were usually seen when they were flying. Nesting bald eagles always flew when the survey aircraft approached (500 ft AGL). Falcons flew if the cliff nests were approached too closely and especially if a cliff was approached from the back side. Not enough quantitative information was obtained for determining specific responses for eagles or falcons.

5.4 Conclusions

The above observations illustrate the great variation in wildlife reactions to aircraft. Not only is there a wide variation between species but also for a specific species during different seasons or when performing different functions. Such variations seem quite logical on reflection, yet too often we fail to acknowledge variation of reactions in wildlife or land management. What is clear is that further studies are required to refine our knowledge of how animals react in the multitude of situations that make up the daily existence of all animals. Only with this knowledge can managers determine the levels of disturbance that can be classed as harassment.

FIGURE: 28



WOLF REACTION TO AIRCRAFT ON WINTERING TERRITORY, (±800 FT AGL) 32 RESPONSES

Plate 17 Muskox on summer range showing panic even before the aircraft flew over (± 10 + 3 X rs 25).

Plate 18 Adult wolf near den exhibiting no response to low-flying survey aircraft (1 WFds 13)

FIELD SURVEY NOTATION SYMBOLS

6.1 Introduction

The survey techniques appropriate for reconnaissance-scale mapping of wildlife require a mixture of evaluation skills from a variety of disciplines. A background in botany, geology and climatology is essential for assessing the relationships of wildlife to geomorphology and vegetation. While flying, it is essential that the surveyor be able to quickly evaluate and note relevant aspects of the geology, geomorphology and vegetation of the survey zone.

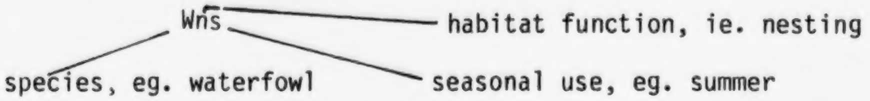
6.2 Symbols

The following brief symbols generally cover all recordable information needed to map wildlife and wildlife habitat at a reconnaissance level. The wildlife and geomorphology symbols are in standard use and are rapidly learned. The vegetation classification is relatively new, but has become the standard classification system. It is also self-explanatory and easily-learned. The advantages of direct field mapping are significant. The information is immediately available for perusal and re-survey if necessary. No tape recorder malfunctions will necessitate expensive re-surveys. Also, information is in a standard form from the start.

6.2.1 Wildlife Symbols

The wildlife symbols used are basically those forming the legend of the Land Use Information Series. In turn these symbols were adapted from those first used in the Arctic Ecology Map Series. The symbol consists of three units; one or two capital letters to designate species; a small letter to designate habitat function; and a further small letter to designate seasonal utilization. These symbols are listed below.

Explanation of Symbol



The use of this symbol would designate an area as waterfowl summer nesting habitat.

CODE	BOUNDARY	SPECIES
AF		Arctic fox
AN		Areas of note
B		Barren-ground caribou
BB		Black Bear
BN		Bison
C		Woodland caribou
CF		Red (colored) fox
G		Grizzly Bear
GS		Ground squirrel
LX		Lynx
M		Muskrat
MK		Mink
MS		Moose
O		Otter
PT		Ptarmigan
RA		Raptor
RE		Rare or endangered species
T		Marten
V		Beaver
W		Waterfowl
WF		Wolf
WV		Wolverine
X		Muskox
	━━━━━	Units notable for two or more species
	— — —	Boundary of a wildlife zone

CODE	BOUNDARY	SPECIES

HABITAT FUNCTION

b	Breeding area
d	Denning area
l	Staging area
m	Migratory route
n	Calving or nesting area
r	Range
t	All habitat functions
⇔	Migration route

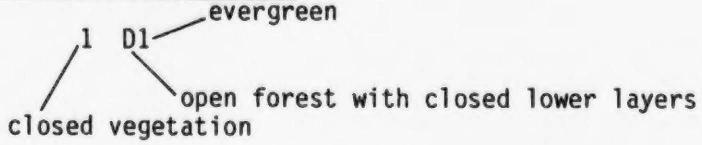
SEASONAL UTILIZATION

s	Spring or summer
w	Fall or winter
y	Year-round use

6.2.2 Vegetation Symbols

The symbols used to map vegetation types are derived from the system outlined by F.R. Rosberg, in "Classification of Vegetation", an appendix of the Guide of the Check Sheet for IBP areas (Peterken, 1967). Since the system is designed for world-wide use the symbols require a little practice in a northern context before they can be used with ease. The symbols (listed below) allow mapping using a three-unit alpha-numeric code, as illustrated.

Explanation of Symbol



Thus, the use of this symbol would designate an open black spruce or jackpine forest with a moss or lichen lower layer. Additional specific notes would be made on ground checks.

CLASSIFICATION

1. Closed Vegetation

A - Forest
(Closed woody vegetation 5 m or more tall)
A1 - Evergreen Forest
(At least the canopy layer with no significant leafless period)

B - Scrub
B1 - Evergreen Scrub
B2 - Deciduous Scrub
(Shrubs periodically bare of leaves, usually in dry season or winter)

C - Dwarf Shrub
C1 - Evergreen Dwarf Shrub
C2 - Deciduous Dwarf Shrub

D - Open Forest with Closed Lower Layers
D1 - Evergreen Open Forest with Closed Lower Layers
D2 - Open Deciduous Forest with Closed Lower Layers

F - Dwarf Shrub with Scattered Trees
F1 - Evergreen Dwarf Shrub with Scattered Trees
F2 - Deciduous Dward Shrub with Trees

G - Open Shrub with Closed Ground Cover
G2 - Open Deciduous Shrub with Closed Ground Cover

H - Open Dward Shrub with Closed Ground Cover
H2 - Open Deciduous Dwarf Shrub with Closed Ground Cover

J - Low Savanna
J1 - Evergreen Low Savanna
(Trees evergreen)
J2 - Deciduous Low Savanna

M - Short Grass
M2 - Seasonal Short Grass

O - Closed Bryoid Vegetation
O1 - Closed Bryophyte Vegetation
O2 - Closed Lichen Vegetation

2. Open Vegetation

A - Steppe Forest
A1 - Evergreen Steppe Forest
(Tree layers, at least, evergreen)

B - Steppe Shrub

B2 - Deciduous Steppe Shrub

C - Dwarf Steppe Scrub
C2 - Deciduous Dwarf Steppe Shrub

H - Bryoid Steppe
H2 - Open Lichen Vegetation

3. Spare Vegetation

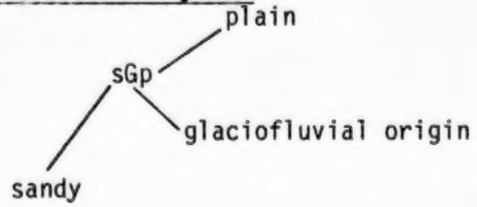
B - Desert Shrub
B2 - Decidious Desert Shrub

C - Desert Herb Vegetation
C1 - Evergreen Desert Herb Vegetation

6.2.3 Geomorphology Symbols

The symbols used to map geomorphology are derived from a system in general use with the Geological Survey of Canada. The symbol consists of a three-unit alphabetical code.

Explanation of Symbol



Thus the use of this symbol would indicate a sandy plain of glaciofluvial origin.

GENTIC LANDFORM CLASS	
A	alluvial
C	colluvial
E	eolian
G	glaciofluvial
L	glacio-lacustrine
M	morainal
W	marine
O	muskeg
R	bedrock

MORPHOLOGY AND SURFACE FORM CATEGORY (placed after landform class)	
p	plain
h	hummocky
m	rolling
k	kettled
r	ridged
t	terraced
v	veneer

TEXTURAL CATEGORY (placed before landform class)	
c	clayey
s	sandy
g	gravelly
r	rocky

REFERENCES AND BIBLIOGRAPHY

Library research throughout the survey has disclosed a large number of papers which have been invaluable. A listing of these papers and reports follows, in two groups. The first group includes selected references found in the text of this report. The second group includes supplementary material broken into five subject areas.

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7.2.2 Environment
7.2.3 Geomorphology
7.2.4 Vegetation
7.2.5 Wildlife

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APPENDIX

PRELIMINARY HABITAT ASSESSMENT
MACKENZIE BISON SANCTUARY, N.W.T.

PRELIMINARY HABITAT ASSESSMENT MACKENZIE BISON SANCTUARY, N.W.T.

TABLE OF CONTENTS

A1 INTRODUCTION 113

A2 METHODS 115

A2.1 Vegetation Analysis 115

A2.2 Plant Identification 115

A2.3 Ecosystem Analysis 115

A3 RESULTS AND DISCUSSION 116

A3.1 Plant Associations 116

A3.2 Plant Succession 120

A3.3 *Carex aquatilis* Meadows 126

A3.4 Forests 126

A3.5 Geomorphology 126

A3.6 Proposed Cause for Lakes Draining 128

A3.7 Periglacial Gemorphology 128

A3.8 Additional Range 130

A4 CONCLUSIONS 133

LIST OF FIGURES

Figure A1 - Mackenzie Bison Sanctuary 114

Figure A2 - Proposed idealized plant succession cross-section 125

LIST OF PLATES

Plate A1 - Wood bison in the Mackenzie Bison Sanctuary 121

Plate A2 - Falaise Lake cattail growth 121

Plate A3 - Birch Lake Sedge Meadows 122

Plate A4 - Dieppe Lake gemorphic and succession stages 122

Plate A5 - Shallow, draining lakes 129

LIST OF TABLES

Table A1 - Species Significance Index 117

Table A2 - *Typha latifolia - Stellaria longifolia* Association 117

Table A3 - *Carex atherodes - Stellaria longifolia* Association 118

Table A4 - *Carex atherodes - Calamagrostis canadensis* Association 118

Table A5 - *Calamagrostis canadensis - Scolochloa festucacea* Association 119

Table A6 - *Carex atherodes - Salex* spp. Association 119

Table A7 - *Carex aquatilis - Salex* spp. Association 119

Table A8 - Proposed plant succession model 124

Table A9 - Bison plant feeding species 132

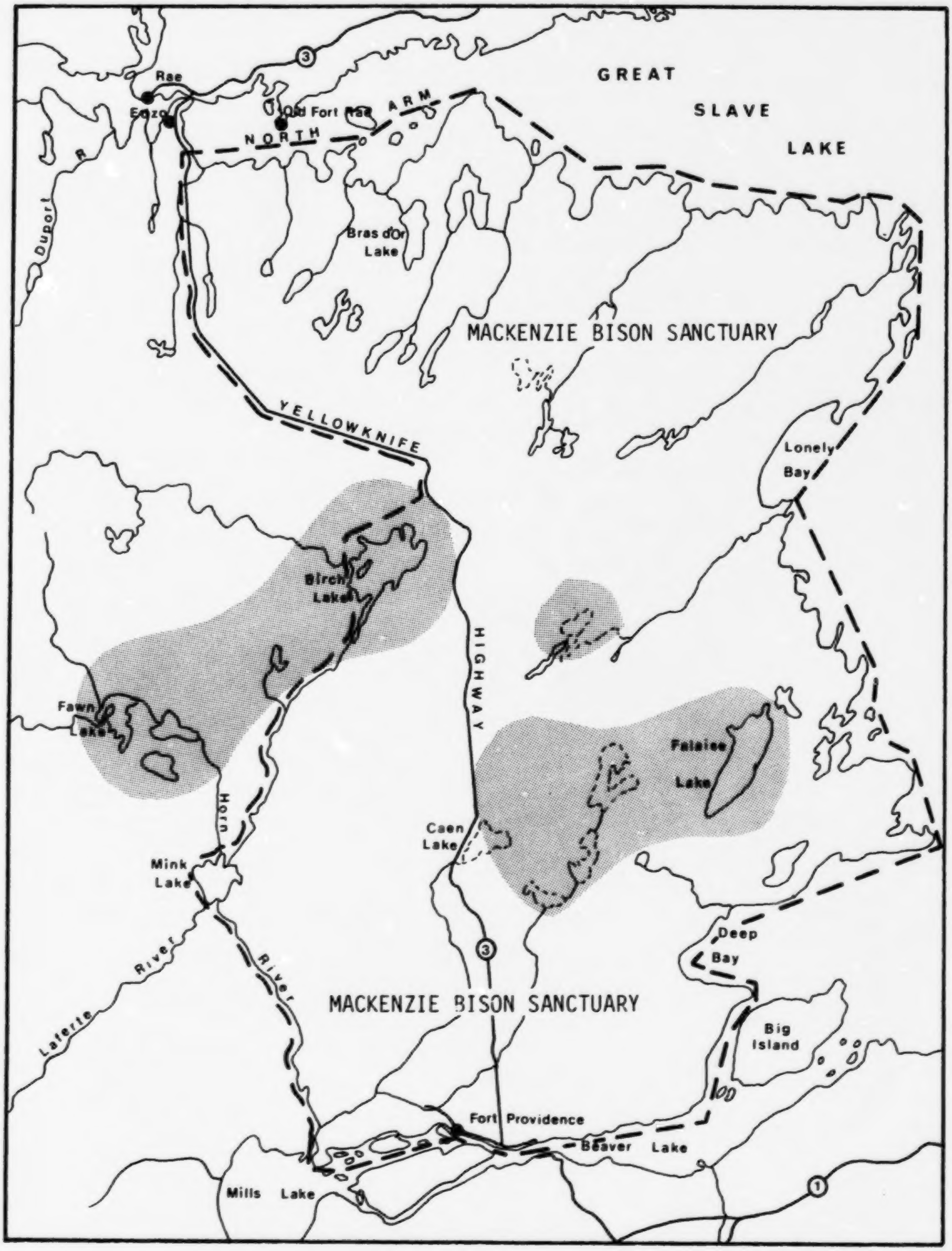
PRELIMINARY HABITAT ASSESSMENT
MACKENZIE BISON SANCTUARY, N.W.T.

A1 INTRODUCTION

The Mackenzie Bison Sanctuary, N.W.T., presently occupies more than 7,000 $mi.^2$ along the west shore of Great Slave Lake, providing habitat for a herd of more than 500 wood bison *(Bison bison;* Plate A1). The sanctuary (Fig. A1) is part of a general wildlife zone, which extends to the northwest and southeast, and encompasses the northern portion of Wood Buffalo National Park. Numerous shallow lakes, large bogs, and extensive spruce and jackpine forests characterize this zone. Terrestrial and arboreal lichens are abundant in the mature spruce stands. Large sedge meadows and willow-sedge parklands surround the shallow lakes. Woodland caribou *(Rangifer tarandus)*, moose *(Alces alces)*, and black bears *(Ursus americanus)*, are common throughout the area. During both spring and fall, large numbers of migrating swans, geese, ducks, and cranes pass through this wildlife zone, feeding and resting on the numerous small lakes and streams. Aquatic and terrestrial furbearers may be found, in suitable habitat, throughout the entire region.

This special study, in addition to, and in more detail than normal Arctic Land Use Research studies, was conducted for the Canadian Wildlife Service and the Northwest Territories Wildlife Service.

FIGURE: A1 Mackenzie Bison Sanctuary


3
Rae
Edzo
Old Fort Rae
NORTH ARM
GREAT SLAVE LAKE
Duport R
Bras d'Or Lake
MACKENZIE BISON SANCTUARY
YELLOWKNIFE HIGHWAY
Lonely Bay
Birch Lake
Fawn Lake
Horn River
Mink Lake
Falaise Lake
Caen Lake
Deep Bay
Laferte River
3
MACKENZIE BISON SANCTUARY
Big Island
Fort Providence
Beaver Lake
Mills Lake
1

■ Large, Grassy Meadows and Extensive Sedge Meadow Areas

A2 METHODS

Field surveys, preceeded by an extensive literature review and airphoto habitat assessment, were begun in February, 1974, to determine wildlife values in the Arctic Land Use Research (ALUR) 1974-75 study area, which includes portions of the Mackenzie Bison Sanctuary. Six days were spent on the ground in the sanctuary from April through September, 1974 and approximately 20 hours of survey flights were flown during this same period, using both light planes and helicopters. Additional surveys were flown during March and July, 1975 and additional ground reconnaissance made during October, 1975 and February, 1976.

A.2.1 Vegetation Analysis

In an attempt to further understand the relationship between the bison and their habitat, vegetation samples were collected on all available occasions, throughout the sanctuary. Samples were obtained during the late-winter, 1974 survey, from an area of concentrated feeding on Dieppe Lake. The sanctuary was visited on foot and samples collected in the Caen Lake vicinity, again in known feeding areas. Floatplane landings were made on Birch Lake and on Great Slave Lake, and vegetation samples, in what appeared to be suitable feeding habitat, were collected. These random collections posed, rather than answered, questions, since the vegetation of the various meadows were not similar. So, in mid-August, the author chartered a light helicopter and spent a long day collecting plant specimens from meadows throughout the sanctuary and adjacent areas. In short, this was an attempt to fill in the gaps and have a complete, even if small, plant collection, from, at least replicate representative meadow-type ecosystems.

A.2.2 Plant Identification

Plant specimens were labled, pressed, and dryed. Identifications were made using Hulten's (1968) taxonomy manual. The individual plant identifications were determined only to genus in several instances. Several species were corrected according to Birch Lake I.B.P. Check Sheet by W. Coby and J. Sneddon, May, 1972.

A.2.3 Ecosystem Analysis

Compilation of field observations and analysis of vegetation association were based on the plant sociology concepts of Braun-Blanquet (1932). The analysis technique was much modified due to omission of several categories. These were omitted due to the small sample size and so not to create the impression of over-accuracy. The analyses (Tables A2-A7) portray, only in general terms, what appear at this time to be the succession stages. Individual plant species from the Mackenzie Bison Sancturary were listed and compared with their occurrence and use by bison on the Peace-Athabasca Delta (Table A9; McCourt, 1970)

A.3 RESULTS AND DISCUSSION

A.3.1. Plant Associations

The 1974-75 ALUR study area covers approximately 107,000 mi.^2 Size and available time allowed only general wildlife investigations. Habitat and vegetation observations were also of a general nature, and not in the detail obtained from longer or less spacially extensive studies. Nevertheless, the following brief description of vegetation and plant associations is representative of the bison sanctuary and adjacent similar areas.

Meadow Composition

In-filling of the numerous shallow lakes in the sanctuary and adjacent region has resulted in many large meadows in the former lake basins. These meadows form the basis for the important bison ranges. The meadows are dynamic ecosystems, with several succession stages, which appear to be related to soil moisture. The following tables (A2-A7) list species found in representative succession stages, from at least replicate samples, in the Mackenzie Bison Sanctuary and adjacent areas. Relative significance (abundance) of the species is also listed. Table A1 gives a brief break-down of species significance and criteria used in assigning an index number.

TABLE A1 Species Significance Index

INDEX	EXPLANATION	% OCCURRENCE
1	Occur Seldom	5%
2	Common	5 - 20%
3	Occur often	20 - 50%
4	Abundant	50 - 75%
5	Very Abundant	75%

(after Braun - Blanquet, 1932)

TABLE A2

SPECIES	RELATIVE SIGNIFICANCE
Typha latifolia	5
Beckmannia sp.	1
Poa sp.	1
Hordeum jubatum	1
Scirpus sp.	1
Eleocharis palustris	1
Carex sp.	1
Stellaria longifolia	2

TABLE A3 *Carex atherodes - Stellaria longifolia* Association

SPECIES	RELATIVE SIGNIFICANCE
Agrostis scabra	1
Hordeum jubatum	2
Carex atherodes	3
Rumex maritimus	1
Stellaria longifolia	2

TABLE A4 *Carex atherodes - Calamagrostis canadensis* Association

SPECIES	RELATIVE SIGNIFICANCE
Calamagrostis canadensis	2
Hordeum jabutum	1
Carex atherodes	4
C. sp.	1
Salix glauca	1
S. spp	1
Plantago sp.	1

TABLE A5 *Calamagrostis canadensis - Scolochloa festucacea* Association

SPECIES	RELATIVE SIGNIFICANCE
Calamagrostis canadensis	4
Poa sp.	1
Scolochloa festucacea	3
Hordeum jubatum	1
Salix spp.	1
Plantago sp.	1
Aster brachyactis	1

TABLE A6 *Carex atherodes - Salix* spp. Association

SPECIES	RELATIVE SIGNIFICANCE
Calamagrostis canadensis	1
Carex atherodes	5
Salix spp.	1

TABLE A7 *Carex aquatilis - Salix* spp. Association

SPECIES	RELATIVE SIGNIFICANCE
Carex aquatilis	5
Salix sp.	1
Plantago sp.	1

A.3.2 Plant Succession

The six ecosystems listed (Tables A2-A7), when examined in detail, and compared with similar investigations, in and adjacent to, Wood Buffalo National Park, are, in fact, part of a general plant succession trend. The following analysis of the individual ecosystems will help to assess bison feeding habitat in the sanctuary.

a) *Typha latifolia - Stellaria longifolia* Association

This association occurs over a large portion of Falaise Lake, throughout the hygric, central part of the former lake basin (Plate A2). The cattail - chickweed vegetation surrounds the small remaining lake body and is used heavily as both summer and winter bison feeding range.

b) *Carex atherodes - Stellaria longifolia* Association

This sedge-chickweed association occupies slightly raised ridges in the former lake beds and is found surrounding most of the basins, where sufficient height offers less moist conditions (Plate A3).

c) *Carex atherodes - Calamogrostic canadensis* Association

A sedge-grass association, with forbs and willows, appears to occupy the most area on the bison feeding meadows (Plate A3). These are relatively dry meadows.

d) *Calamagrostis canadensis - Scolochloa festucacea* Association

Very dry portions of the former lake beds appear to have succeeded to a largely grass association. These extensive meadows may be found throughout the sanctuary and especially in the area designated in Plate 14.

e) *Carex atherodes - Salix* spp. Association

This sedge meadow is very dry and appears to be succeeding to willow-sedge parkland. Dry meadows of this type may be found east of Birch Lake (Plate A4).

f) *Carex aquatilis - Salix* spp. Association

Wet sedge meadows occur commonly throughout the entire region, including the bison sanctuary. These wet meadows are the most abundant potential bison feeding range and are both numerous and extensive (Plate 1).

g) Comparisons with Previous Research

Halsworth (1960) working with bison associated with Wood Buffalo National Park, found a general increase in *Scolochloa* and *Calamagrostis* species with changes from mestic to dry soil conditions. The driest areas had an abundant *Calamagrostis* growth and ridges had large amounts of *Hordeum*. In the Mackenzie Bison Sanctuary, progressively dryer conditions in former lake basins generally show this same sequence (Tables A2-A7). He suggests former lake draining as the cause of the meadow formation, not fire. This

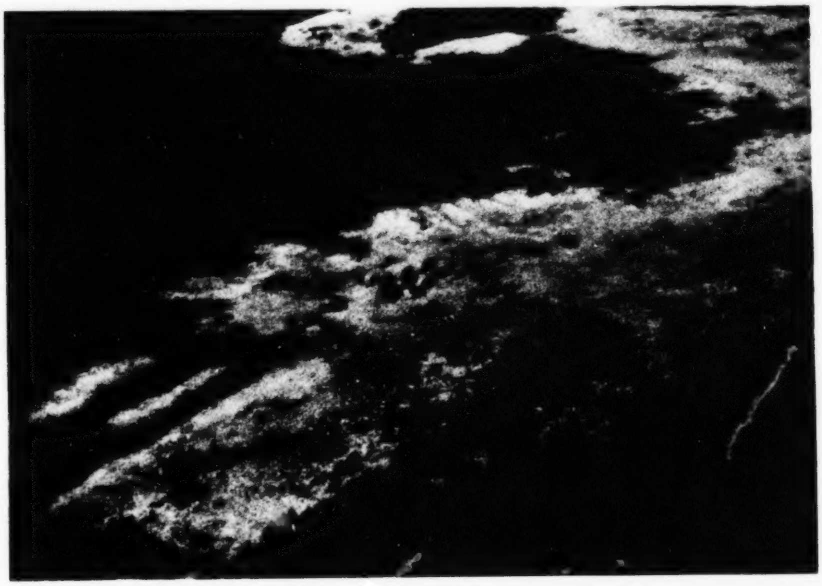


Plate A1 Wood bison in the Mackenzie Bison Sanctuary on summer range.

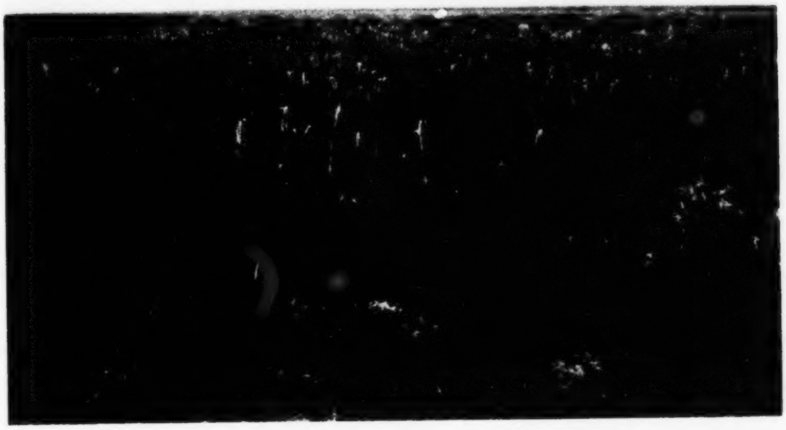


Plate A2 Much of the wetter central portion of the former Falaise Lake bottom is covered with a dense growth of cattail (Typha).

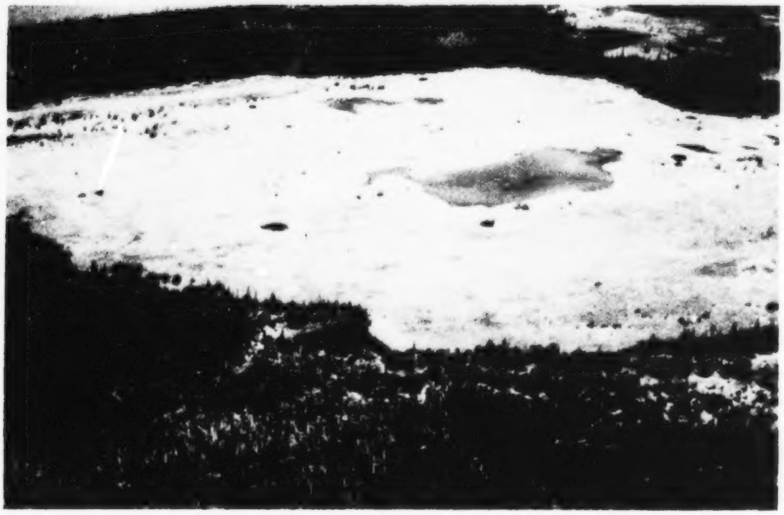


Plate A3 Relatively dry sedge meadows can be found east of Birch Lake.

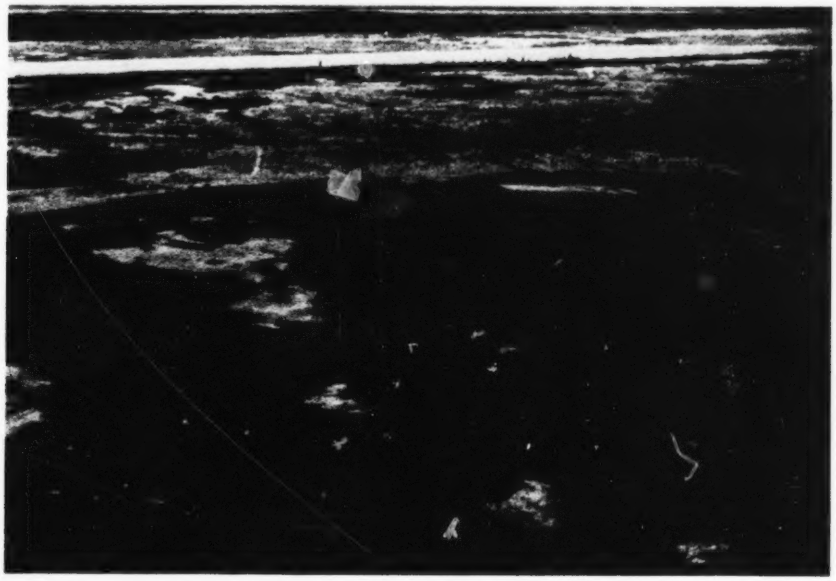


Plate A4 Dieppe Lake, Mackenzie Bison Sanctuary, prime bison range. Most of the geomorphic and succession stages, and vegetation types found in the sanctuary are illustrated here. Oriented shallow lakes and jackpine-covered ridges are the result of glacial fluting. Plant succession progresses from emergent vegetation, through willow-sedge parkland, to spruce forests. The lakes are slowly draining, providing more meadow habitat. Vegetation appears to be inhibited in many spots. Ice-shoving, in the former lake basin, formed the many linear ridges.

appears to be the case in the bison sanctuary also.

Pringle (1971), who also worked with park bison, states that *Calamagrostis canadensis* succeeds *Carex atherodes* and offers observations to support his judgement. He also found willows (*Salix* spp.) and *Calamagrostis canadensis* in association with the *Carex atherodes* in successional stands. Equally as important, he found *Hordeum jubatum* in drier areas and *Typha latifolia* undergoing succession to sedges and grasses. Pringle's observations also are applicable to the Mackenzie Bison Sanctuary (Tables A2-A7). Further, he also described separate *Carex aquatilis* - *Salix* spp. areas (as opposed to *Carex atherodes* meadows). Such *Carex aquatilis* meadows are also separate and numerous in the bison sanctuary.

h) Proposed Succession Model

Pringle (1971) offers a model to explain plant succession in bison feeding areas of Wood Buffalo National Park. He suggests parallel succession, from wet (lake) conditions through dry upland,

(1) from emergent vegetation, through *Carex aquatilis* to *Hordeum jubatum* and

(2) from *Scolochloa festucacea*, through *Carex atherodes*, *Calamagrostis canadensis* and *Salix* spp., to forest.

I suggest the following, tentative model for plant succession on bison feeding areas (and potential range) in the Mackenzie Bison Sanctuary (Table A8). Additionally, an idealized cross-section, detailing plant succession, is offered (Fig. A2).

TABLE A8. Proposed plant succession model in the Mackenzie Bison Sanctuary

SOIL MOISTURE CONDITIONS	REPRESENTATIVE PLANT ASSOCIATIONS
Hygric	*Bacillariophyceae*[*]
Hygric	*Typha latifolia - Stellaria longifolia*
Hygric-Subhygric	*Carex atherodes - Stellaria longifolia*
Subhygric	*Carex atherodes - Calamagrostis canadensis*
Mesic	*Calamagrostic canadensis - scolochloa festucacea*

[*] See waterfowl utilization section

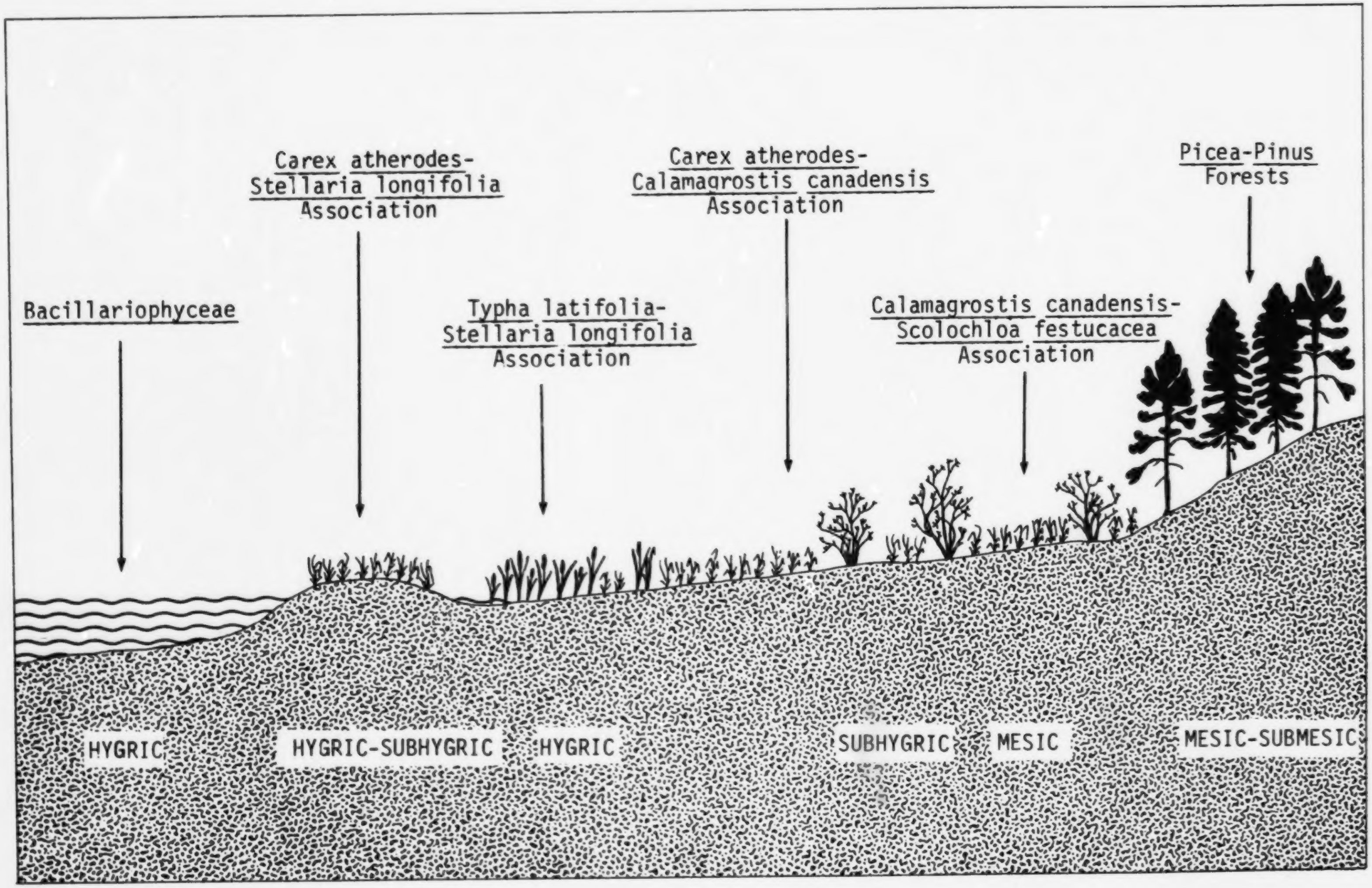

Bacillariophyceae
Carex atherodes-
Stellaria longifolia
Association
Typha latifolia-
Stellaria longifolia
Association
Carex atherodes-
Calamagrostis canadensis
Association
Calamagrostis canadensis-
Scolochloa festucacea
Association
Picea-Pinus
Forests
HYGRIC
HYGRIC-SUBHYGRIC
HYGRIC
SUBHYGRIC
MESIC
MESIC-SUBMESIC

Fig. A2 Proposed idealized plant succession sequence, related to soil moisture conditions, in bison feeding areas in the Mackenzie Bison Sanctuary, N.W.T.

A3.3 *Carex aquatilis* Meadows

While the preceeding succession discussion hopefully describes the basic sequence of meadow development in the former lake basins, many large expanses of sedge meadows do not fit neatly into this proposed scheme. *Carex aquatilis - Salix* spp. meadows occupy large areas in the central and northern portions of the present sanctuary and, especially noteworthy, comprise most of the potential, currently unused, bison range west of the sanctuary. Following is a brief discussion of these sedge meadows.

The *Calex aquatilis* meadows (Table A7) are the typical examples of sedge meadows. Vegetative in-filling of the shallow, glacially-formed lakes and ponds, where the water table remains relatively constant and very near the surface, results in these *Carex aquatilis* meadows. Further succession, by vegetative build-up, leads to the typical willow-sedge parkland, and willow-aspen to aspen-spruce, and finally spruce forests. The *Carex atherodes - Calamagrostis canadensis* association described (Table A6), is an anomalous situation. I suggest that a gradual water table lowering, amply evidenced in the Birch Lake vicinity, is responsible for this association. This is still a typical sedge meadow but the grass component indicates a drying, not due to vegetative in-filling, but instead to an interruption, or change, in the succession cycle; a lowering of the water table.

A3.4 Forests

Forests in the Mackenzie Bison Sanctuary occupy at least 50% of the area and appear to reach two climax stages. The first of these, largely black spruce, *(Picea mariana)* with some larch *(Larix laricina),* the second, fire-related subclimax jackpine *(Pinus banksiana)* forests.

a) Spruce Forests

Succession throughout the sanctuary appears to proceed from natural, eutrophic in-filling of ponds, through sedge and willow stages, to aspen and larch with spruce. Spruce-lichen forests appear to be the climax association.

b) Jackpine Forests

Semi-dry ridges in the sanctuary, where affected by fire, appear to regenerate to jackpine. Those open forests have a grass component in their understory and would be of some importance to bison.

A3.5 Geomorphology

Geomorphic and geologic influences, the too-often neglected and extremely important, components of ecological investigations, are instrumental in providing virtually all suitable bison feeding areas in the Mackenzie Bison Sanctuary. Both meadow types, basic drainage patterns, and ultimate soil moisture conditions are in response to physiographically imposed conditions.

a) Glacial Geomorphology

Glaciation, presumably of Wisconsin age, has had the most obvious physical effect on the region in which the Mackenzie Bison Sanctuary lies. In chronological order, from oldest to youngest, the following glacial sequence is suggested for the region between the Horn Plateau and Lac la Martre, and including the bison sanctuary. This sequence is based on observations, not detailed cross-section and fabric analyses.

b) Glacial Flutings

The glacial features most apparent in this study area are numerous glacial flutings. The flutings have been superimposed on the Cartridge Plateau and adjacent region, immediately west of Lac la Martre. They extend, in a northwest-southeast direction, almost to Birch Lake.

A more recent set of flutings has been superimposed, on these ridges, from the northwest. These flutings are from a southwest moving glacier and can be observed throughout the bison sanctuary.

Glacial flutings are very important in determining the extent that soil moisture conditions can be suitable for meadow development. While their ultimate derivation is from the glacial till superimposed on the entire region (Shaw and Freschauf, 1973), the ridges, by their height above the water table, provide conditions similar to eskers, producing dryer soil conditions and resulting in numerous parallel ridges of forests, with intervening, elongated shallow lakes.

c) Glacial Till

A covering of clays, glacial till, has been superimposed on the entire region. These clays, fine-grained by definition, further determine the ultimate potential of bison feeding areas in the sanctuary. Clays, by being extremely fine-grained, as easily saturated, and hold water near the surface, resulting in an abundance of hygric plant species as opposed to vegetation requiring dryer situations.

d) Glacial Moraine

A large, water-worked glacial moraine, lies along virtually the entire western boundary of the bison sanctuary, northwards from Brich Lake. With respect to bison range, or in this case, lack of it, the moraine is covered with a jackpine *(Pinus banksiana)* forest. This drier forest situation is typical of moraines.

e) Glacio-lacustrine Deposition

From observations throughout the western portion of the 1974-75 ALUR study area, it appears that large areas were part of a post-glacial lake. This lake deposited clay throughout the bison range, also affecting vegetation, similar to the effects of till.

f) Karst Geomorphology

The entire sanctuary is underlain by calcareous ricks, largely limestone, dolomite, and gypsum. The significance of these geologic formations assumes greater importance with discovery of the underground movement of fishes in Wood Buffalo National Park (Nelson and Paetz, 1974). This area has similar geologic formations as the bison sanctuary. Underground movement of water, typical of calcareous formations, results in karst topography; caves. Sinkholes, indicative of karst topography, may be observed in the sanctuary, especially in the eastern portion.

A3.6 Proposed Cause for Lakes Draining

The many shallow lakes in the region are observed to have had higher water levels in the recent past (Plate A5). As the areas formerly occupied by the lake bottoms are presently the most utilized bison feeding range, any habitat analysis must attempt to understand why the meadows occur where they do.

Normally, one would suspect a change in evapotranspiration rates, due to forest fires, to account for raising water levels (after fire and decreased loss of moisture due to evapotranspiration) and a gradual lowering of the water levels after forest regrowth. No evidence of dead, drowned forests exists on the former lake margins. Furthermore, adjacent lakes in the sanctuary are draining at different rates. Additionally, thermal erosion of permafrost does not seem to account for this lake draining situation.

The remaining most likely cause for lake draining in areas underlain by calcareous materials is underground drainage, associated with karst geomorphology. This has been shown to occur in this region, in the same geologic province, and evidence for karst topography has been observed in the bison sanctuary. I suggest underground karst drainage as the cause for the lakes slowly draining.

A3.7 Periglacial Geomorphology

An aspect of the physical environment of extreme importance in northern regions are the actions of ice and snow, here classed as periglacial features.

a) Permafrost

Underground ice does not appear to be continuous throughout the bison sanctuary, at least at shallow observable depths. Permafrost was found, at approximately 1m depth, under mature black spruce forests with sphagnum and lichen understories, in late August. Permafrost does not seem to have a major affect on bison habitat.

b) Ice-Shoved Ridges

In virtually all large lakes in the sanctuary and adjacent region, effects of lake ice can be found. Either by wind-driven ice in spring, or most probably by expansion of ice frozen to the lake bottom, ridges have been formed on the lake beds. These are often large features in the lake bed and rise up to 1m in height, as in Birch Lake. Such ridges make float-

Plate A5 Many of the shallow lakes appear to be slowly draining, providing potential bison range.

plane landings hazardous in the sanctuary. Where lake beds are now dry and vegetation covered, these ridges are an important feature. They are generally the hygric-subhygric *Carex atherodes - Stellaria longifolia* associations and Holsworth's (1960a) ridges with large amounts of *Hordeum*.

Bacillariophyceae Occurrance

Waterfowl utilize the numerous small lakes and ponds, during both spring and fall, for feeding and resting. Canada geese appear to feed heavily on an algea *(Bacillariophyceae)* in the shallow lakes. This was observed throughout the sanctuary and adjacent region.

Further comment is perhaps justified on the algea *(Bacillariophyceae)*. The algea (colonies) do not appear to be distributed the same in every lake. Ice freezing to the bottom would not seem to be a factor, though considered, as virtually none of the lakes is deep enough to not freeze to the bottom. My suggestion is that the algae has an affinity with the calcareous substrate. Glacial till (and lacustrine) deposition has covered this substrate evenly. But the underlying substrate does not necessarily exhibit a uniform relief. Therefore, perhaps the distribution of this algae is related to a geologic-geomorphic interaction.

A further comment on this algae concerns its possible vegetation inhibiting properties. Throughout the sanctuary, lakes with this algae do not have other aquatic vegetation. Further, and more important to bison, lakes which have drained that have this algae as a thick bottom layer, do not have rapid sedge and grass succession (Plate 15).

Novakowski (1966) offers several pertinent observations about the algae mentioned above, which he describes as a component of marl. He refers to inorganic salts as a component of this marl. Novakowski also directly relates whooping crane nesting and feeding areas to representative plant species. Bulrush *(Scirpus validus)* is noted as the important nesting area species and cattail *(Typha latifolia)* and sedge *(Carex aquatilis)* are related to the feeding sites. It is interesting to note the presence of these plant species in the Mackenzie Bison Sanctuary. With similar geology, geomorphology, and vegetation, the bison sanctuary, especially the northern half, should be considered potential whooping crane nesting habitat.

A3.8 Additional Range

The Mackenzie Bison Sanctuary has, not surprisingly, very similar habitat to that found in and adjacent to Wood Buffalo National Park. Vegetation associations and plant succession have been shown to be similar. The bison in the sanctuary are rapidly expanding in numbers however. Further, use of the winter range appears very heavy, in a limited area. This was also apparent in 1975. Especially in light of impending massive reduction in the size of the bison sanctuary, one must make judgements on (1) whether the bison will continue to expand their range, and (2) the quality of any additional range.

a) Comparison with Peace-Athabasca Delta

McCourt (1970) tabulated plant species in bison feeding areas on the Peace-Athabasca Delta. He analyzed the plants with respect to occurrence, cover, and utilization in these feeding areas. In Table A9 I have listed cover, and utilization in these feeding areas. In Table A9 I have listed major meadow species which occur in the Mackenzie Bison Sanctuary and compared them with results from McCourt's study. By studying such a table, one can determine, with a reasonable degree of assumed accuracy, (1) whether the bison may move into an area and (2) the relative usability of the potential range.

b) Additional Grass Meadows

Large *Calamagrostis canadensis* - *Scolochloa festucacea* meadows occur immediately north of the present bison range (Fig. A1). These meadows are expansive, and information listed on Table A9 indicates that these species are apparently very palatable to bison. While the bison don't have the benefit of my assessment that they should move in this direction, they have moved farther distances through forests, as between Falaise and Boulogne lakes. A series of meadows, with only small intervening forest patches, leads from present range to these grassy meadows.

c) Additional Sedge Meadows

Perhaps the most abundant potential bison ranges in the sanctuary vicinity are the *Carex aquatilis* meadows west of Birch Lake Fig. A1). These areas, also apparently very palatable to bison, occupy many acres, as indicated. Again however, it is only speculation that the bison will move to these sedge areas. But, the rate of population increases, from 18 bison in 1963 to 152 in 1974 (to > 500 in 1978), indicates that their future range needs must at least be speculated upon.

TABLE A9 Percent occurrence, cover, and cropped plants of bison feeding areas on the Peace-Athabasca Delta, plant species from the Mackenzie Bison Sanctuary.

SPECIES	% OCCURRENCE	X % COVER	% CROPPED
Typha latifolia			
Agrostis scabra	20		6
Calamagrostis sp.	72	1	37
Poa sp.	10		13
Scolochloa festucacea	24		59
Hordeum jubatum	4		0
Scirpus validus	16		35
Eleocharis palustris	34		0
Carex aquatilis	48		64
Carex atherodes	100	30	80
Salix spp.	24		0
Rumex maritimus	68		0
Stellaria longifolia	4		0
Rorippa islandica	48		0
Plantago sp.	22		0

(after McCourt, 1970)

A4 CONCLUSIONS

This preliminary habitat assessment of the Mackenzie Bison Sanctuary has shown it to be an extremely complex area. Six major plant associations were identified and a succession sequence suggested. An explanation was offered for the lake drainage and meadow formation. Suggestions were offered to explain the non-vegetated meadows and some differences in meadow composition.

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